

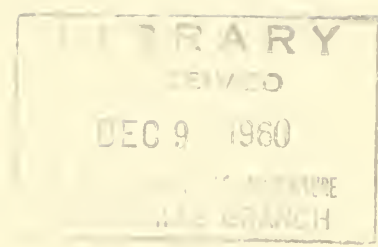
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# ABSTRACTS

of recent published material on  
Soil and Water Conservation

**Number 18**

**ARS 41-39**  
Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

"ABSTRACTS of recent published material on Soil and Water Conservation" is abstracted by Charles B. Crook in the Soil and Water Conservation Research Division of the Agricultural Research Service.

They are issued bi-annually. Their purpose is to bring together a summary of current published information about soil and water conservation for ready reference of those actively engaged in soil and water conservation work. Reprints of abstracted articles are generally not available in the Division. Requests for reprints should be sent to authors or institutions--addresses have been appended to each abstracted article.

This ABSTRACT consists principally of articles abstracted from the following: (1) Soil Sci., and Soil Sci. Soc. Amer. Proc., 1958 through June, 1959; (2) foreign journals abstracted for the period 1957 through June, 1959--Canad. J. Soil Sci., Netherlands J. of Agri. Sci., New Zealand J. of Agr. Res., Soil and Plant Food (Japan), and J. Soil Sci. (Great Britain); (3) applicable Federal publications 1957 through 1959; and (4) 1958 and 1959 publications on soil and water conservation from the following State Agricultural Colleges--Alabama, Alaska, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, and Georgia.

The classification of articles has been changed to agree with the table of contents used by the Soil Conservation Service for the "Soil and Water Conservation Research Needs." Charles B. Crook has abstracted completely enough so article need not be consulted unless details are required. When an entire number of a publication is devoted to reviewing one subject then the entire publication is abstracted as one article giving title and authors of each paper included in the publication. Abbreviations of journals and addresses are the standard ones set up by the U. S. D. A. Library in U. S. D. A. Misc. Pub. 765, July 1958.

This is the EIGHTEENTH of the publications issued under this title. The following previous issues are not available for distribution: (1) USDA-SCS (Processed), March 1949; (2) USDA-SCS (Processed), Sept. 1949; (3) USDA-SCS (Processed), July 1950; (4) USDA PA-143, Nov. 1950; (5) PA-173, June 1951; (6) USDA PA-192, Dec. 1951; (7) USDA PA-213, Oct. 1952; (8) USDA PA-228, July 1953; (9) USDA ARS-41-1, Dec. 1954; (10) USDA ARS-41-3, Aug. 1955, and (11) USDA ARS-41-5, Dec. 1955.

The following are available for distribution.

(12)	USDA	ARS-41-8	July	1956
(13)	USDA	ARS-41-17	July	1957
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(15)	USDA	ARS-41-30	Feb.	1959
(16)	USDA	ARS-41-35	Aug.	1959
(17)	USDA	ARS-41-38	May	1960

Authors of articles and reports in the field of soil and water conservation are urged to supply abstracts, reprints, or copies to:

R. S. Dyal, Soil and Water Conservation Research Division, Agricultural Research Service, U. S. Department of Agriculture, Plant Industry Station, Beltsville, Maryland.



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## WATERSHED ENGINEERING

### Hydrology

SIXTH NATIONAL WATERSHED CONGRESS. 153 pp. May 1959.

The Sixth National Watershed Congress was held in Washington, D. C. on May 25 to May 27, 1959.

Introductory remarks were presented by C. R. Gutermuth followed by: The March of Watershed Progress by Clifford Hope; The Federal Role in Watershed Programs by Donald A. Williams; State Governments' Contributions to Watershed Progress by Herbert B. Eagon; Local Organizations Contributions by William E. Richards; and an address by Ezra Taft Benson.

The following watersheds were discussed: The Walnut Creek Watershed Story by C. C. Rich and T. S. Vanasek; The Cypress Creek Watershed, Union Creek, Kentucky by Sam. M. McElroy; The Pleasant Creek Watershed by Grant Johansen; A Pilot Watershed Program for Salem Fork of Tenmile Creek, Salem, West Virginia by Herschel D. Wade; The Blue Ridge Mountain District SCD, Mountain City, Georgia by Harry L. Brown; and Mule Creek Pilot Watershed Project by Dallas N. McGrew.

Various committees reported as follows: Public Understanding by Eleanor E. Hanlon; Non-Agricultural Objectives of Small Watershed Conservation Work by Richard W. Smith; Water Rights by Matt Triggs; Irrigation and Drainage by Elmer H. Talbert; Cost Sharing and Cost Allocation by Walter C. Gumbel; Flood Protection by A. S. Spencer and Non-Agricultural Objectives of Small Watershed Conservation Work by William Voigt, Jr.

The Tuesday afternoon session was devoted to "Meet the Public" and Wednesday morning was devoted to a tour of the Rock Creek Watershed.

C. R. Gutermuth. Wildlife Mangt. Inst., Washington, D. C.

On May 1, 1957, the Colorado Legislature enacted a ground-water law which provides control over "... any water not visible on the surface of the ground under natural conditions."

The law provides that within three years from the effective date of the act all ground-water users must register existing wells with the state engineer. New wells cannot be drilled or the supply of water from existing wells increased unless the user applies to the state engineer for a "Permit to Use Ground Water." The state engineer will issue the permit unless it comes from within a "Tentatively Critical Ground-Water District."

When a district is declared tentatively critical, the commission establishes boundaries and closes the area to further ground-water development. The state engineer has the power to refuse to issue "Permits to Use Ground-Water" in critical districts except for:

1. Wells used solely for stock watering purposes.
2. Domestic wells having discharge pipes of 2 inches or less.
3. Artesian wells with discharge pipes not exceeding 3 inches in diameter.
4. Or, to replace, deepen, or reconstruct wells in need of restoration which have been in operation for more than one year prior to the date the law took effect.

Colo. State U. Expt. Sta., Fort Collins, Colo.

Agricultural Research Service EVALUATION OF AGRICULTURAL HYDROLOGY BY MONOLITH LYSIMETERS. U.S.D.A., A.R.S. Tech. B. 1179, 166 pp. 1959.

A progress report on lysimeter investigations carried on at the Soil and Water Conservation Research Station near Coshocton, Ohio, from 1944 through 1955. Summaries of percolation data are presented for the period 1938-55.

The hydrologic data were obtained from 11 monolith lysimeters, each 0.002 acre in area and 8 feet deep, 3 of which were weighed automatically every 10 minutes. The features of the installations, some of which are unique, are described briefly. Unlike many lysimeters, percolation from the soil into cracks and crevices of the rock at the 5-foot depth takes place naturally without supplying extra tension. Records of this percolation water collected at the 8-foot depth along with records of precipitation and runoff, are presented in tables and graphs for each lysimeter. Weight records provided data for determination of moisture storage changes in the monolith. Daily gains in weight not associated with periods of precipitation were designated as condensation and absorption. Evapotranspiration values were derived from the weigh records in like manner during periods of loss.

The correct value of net moisture depletion is "evapotranspiration minus condensation-absorption," or  $ET - CA$ . These consumptive-use values varied from season to season as affected by the climate, crop, and supply of soil moisture. The highest rates of consumptive use for cornland were in July and August. Those for grassland were in May and June. Irrigation tended to prolong the high water-use rate for grass into late July and August and for corn until late August.

The amount of water used to produce a pound of corn crop ranged from 273 to 586 pounds. The most efficient use of water occurred with irrigation and the highest crop yield (196 bushels of corn per acre). Actually, the least amount of water--17 to 19--inches was used in producing the lowest yields but represented the greatest unit amount of water per unit of crop. A total of 23.5 inches of water was used in producing the highest yield of corn.

Graphs of accumulated daily consumptive use of water reflect various farming operations such as: (1) Reduction of water use after spading sod for corn planting, (2) increase in water use as leaf area of corn plant develops, (3) reduction of water use after cutting and removal of hay, (4) increase in water use as meadow crop leaf area develops, and (5) increase in water use after irrigation in August.

Lysimeter evapotranspiration is compared with pan evaporation and atmometer water loss for several years and for several crops. In some periods evapotranspiration and pan-evaporation rates were about equal. In other periods evapotranspiration from

cornland exceeded pan evaporation by as much as 40 percent for nearly 2 months. Evapotranspiration also exceeded water loss from the white atmometer bulbs, but by lesser amounts.

Bibliography of 134 references.

ARS, USDA, Inform. Div., Washington, D. C.

Neff, E. L., and Sheffer, P. C. DETERMINATION OF PEAK DISCHARGE-FREQUENCY RELATIONSHIPS FOR STREAMS WITHIN A SELECTED AREA IN CALIFORNIA. U. S. D. A., A. R. S. 41-32, 20 pp. 1959.

One of the more common problems facing an engineer or hydrologist is that of finding discharge-frequency relationships for areas in which there are no adequate stream-gaging records available. Several methods are in use by which frequency curves can be synthesized. Among these are the so-called "rational method," unit hydrograph procedures, and regional stream studies. Each of these, in one way or another, takes into consideration climatic and physiographic factors which influence peak rates of runoff. This report presents the results of a regional stream study conducted using stream records from U. S. Geological Survey gaged watersheds on the western slopes of the Sierra Nevadas.

Regional stream studies are confined to areas, called hydrologic zones or provinces, in which there is a similarity in the following climatic and physiographic characteristics:

Precipitation

1. Distribution through the year.
2. Amounts and rates.
3. Form-whether rain or snow.

Topography

1. Elevation.
2. Land and channel slopes.
3. Watershed shape.

Geology

Soils

Each of these factors is evaluated graphically or statistically to determine its influence on frequency curves of annual peak discharge from recorded data within a hydrologic zone. The results of such an analysis can then be used to estimate frequency curves for ungaged watersheds that lie within the same hydrologic province.

ARS, USDA, Inform. Div., Washington 25, D. C.

## Geology

Bittinger, M. W. GROUND WATER IN COLORADO. COLORADO'S GROUND-WATER PROBLEMS. . . Colo. Agr. Expt. Sta. B. 504S, 28 pp. 1939.

Colorados' ground-water, its source, use, and conservation are discussed.

Colo. State U. Expt. Sta., Fort Collins, Colo.

Muckel, D. C. REPLENISHING UNDERGROUND WATER SUPPLIES ON THE FARM. U. S. D. A. L. 452, 8 pp. 1959.

Beneath the surface of the ground are water basins with unused storage capacity far in excess of the largest surface reservoirs. In many localities, farmers who irrigate can use these underground reservoirs as supplements to ponds and other surface basins by storing water in them for later use.

The practice of depositing water in subsurface storage basins is called artificial recharge. It conserves water and raises water-table levels.

Flood water, waste water, and water above that needed for irrigation are good sources for potential underground storage.



Five methods are used (Basin, Furrow, Flooding, Shaft or Pit and Injection Well). Each method lets the water infiltrate through the soil and seep down to the waterbearing formations. The best sites on which to conduct artificial recharge operations permit convenient control of the water and maximum penetration into the soil. Farmers should consider the geological structure of their land and the location of their wells before selecting a recharge method or a recharge site.

Irrigation systems may convey water to recharge sites. Special systems are sometimes needed. The ideal system is a combination of surface reservoirs and efficient recharge sites. The surface reservoirs impound flood flows and simultaneously remove silt and bedload. Releases from the surface reservoirs can be adjusted to suit the capacity of the recharge sites.

Find out where the water-bearing formations are. Draw contour maps to establish the direction in which the underground water moves. Locate your recharging site "up-slope" from your wells. Orient it in such a way that the deposited water follows the underground channels and actually replenishes your well.

Soils that contain sand and gravel offer the least resistance to the penetration of water. The poorest crop-producing soils often make the best recharging sites.

Formations beneath the soil that reduce the passage of water include hardpan layers, clay, silt, or cemented sand or gravel. To avoid recharging above such formations, examine well logs. If no well logs are available, drill exploratory holes.

Sometimes the exploratory holes or the well logs show that impervious strata slant between the surface and the water-bearing formations.

The formations can still be replenished if their natural intake can be located and recharging operations done there.

ARS, USDA, Inform. Div., Washington 25, D. C.

## Snow Surveys

Anderson, H. W., Rice, R. M., and West, A. J. SNOW IN FOREST OPENINGS AND FOREST STANDS. Soc. Amer. Foresters Proc., Salt Lake City, Utah, pp. 46-50. 1958.

In California the snow zone occupies only 12 percent of the area of the state; yet it yields 51 percent of the water. About two-thirds of this yield comes from the commercial forest belt. However the forest influences snow accumulation and melt has direct bearing on water yields; and how the forest is managed, is, inescapably, one way that water yield is managed.

As one of the first steps in developing ways of managing the forests for water, we are studying how snow accumulates and melts in natural forest openings and within coniferous forest stands. This study is under way at the Central Sierra Snow Laboratory--just below Donner Summit on the Sierra west side.

In the year of very heavy snowfall, 1957-58, forest effects on snow accumulation and melt were clearly evident. Snow measurements have provided some clues as to how forests may be cut to improve the timing and increase the amount of water yield. In 1958 the snow pack had 14 more inches of water in forest openings than in high density forest stands. Forest openings 1 to 2 tree heights across had more snow left on June 1, 1958, than did smaller or larger openings. Choice of the correct shape and orientation of forest openings for various slopes can increase the snow storage; L-shaped openings for east and west slopes are probably best. Selective cutting of forest stands can increase snow storage from 2 to 9 in. June 1 snow water storage was a maximum at forest densities less than 80 percent.

Calif. Forest and Range Expt. Sta., FS, USDA, Berkeley, Calif.

## WATERSHED MANAGEMENT

### Irrigation

Blaney, H. F. MONTHLY CONSUMPTIVE USE REQUIREMENTS FOR IRRIGATED CROPS. J. Irrig. and Drain. Div. Amer. Soc. Civ. Engin. Proc. 1963 IR 1: 1-12. March, 1959.

Monthly consumptive use (evapotranspiration) data are useful in determining the disposition of precipitation and its contribution to the ground-water supply, safe yields of ground-water basins, water yields from mountain watersheds, and irrigation requirements of crops. Results of monthly determinations of evapotranspiration and transpiration for irrigated crops may be employed to plan irrigation schedules and for estimating water requirements for each crop for maximum production.

In recent years there has been considerable research on evaporation and consumptive use of water. However there is a need for additional studies. The importance of a knowledge of water lost through evaporation and consumptive use to the efficient design and later operation of the works involved in a water-supply project has long been recognized by engineers.

This paper presents data on measured monthly rates of consumptive use of water for different irrigated crops growing in Western United States and describes a procedure for determining monthly consumptive use requirements for irrigated crops from climatological data for areas where monthly measurements of water use are not available.

SWCRD, ARS, USDA, Los Angeles, Calif.

Van Bavel, C. H. M DROUGHT AND WATER SURPLUS IN AGRICULTURAL SOILS OF THE LOWER MISSISSIPPI VALLEY AREA. U.S.D.A., A.R.S. Tech. B. 1209, 93 pp. 1959.

Daily soil-water balances were computed for 25 years of record and for 81 locations in the Lower Mississippi Valley area. These balances were based on recorded amounts of daily precipitation and on estimated values of daily evaporation from a vegetated land surface. Furthermore, the soil was assumed capable of retaining certain maximum amounts of water available to plants. These amounts ranged from 1 to 5 inches.

From the computations it was determined: (1) on how many days in each month of record the available supply of soil moisture was exhausted; (2) how much rainfall fell in excess of the soil storage capacity for each month of record.

The data was presented partly as graphs and charts and partly in the form of tables. For this purpose the entire area of study was broken up into a number of sections, each comprising from three to six stations.

The data as reported enable one to determine for a given section and time of year the probability for occurrence of deficits and excesses of soil moisture of given severity. In cases of deficits, the required amounts of irrigation water have also been estimated.

One may ascertain the severity of drought incidence in a location for certain soil conditions. The recurrence value of a drought as it happened may be determined and related to the plant response in an irrigation or fertilizer trial. The demand for irrigation water may be anticipated for long-range planning or for the design of individual water-supply systems.

The excess of soil water and its relation to drainage and leaching of plant nutrients can be estimated for specific areas and soil conditions.

ARS, USDA, Inform. Div., Washington 25, D. C.

Ward, H. S., Van Bavel, C. H. M., Cope, J. T., Jr., Ware, L. M., and Bouwer, H. AGRICULTURAL DROUGHT IN ALABAMA. Agr. Expt. Sta., Ala. Polytech. Inst. B. 316, 53 pp. 1959.

An estimate of drought occurrence in Alabama was made on a basis of past climate records. The 25-year record (1930-1954) of daily precipitation from 27 stations was used in this study. Estimated values of daily evapotranspiration was calculated by use of the

Penman formula. The state was divided into northern and southern evapotranspiration areas. By use of the precipitation and evapotranspiration data, daily soil moisture balances were computed and the daily soil moisture balances were used to determine the number of drought-days.

Root occupancy of various soil types are presented along with the available moisture holding capacity in inches per foot for the principal soils in the State.

This study has clearly shown that drought occurrence is to be expected during the summer and fall in Alabama. As a result there are even odds that optimum crop yields cannot be attained because of this drought hazard. The data also reveal that drought occurrence depends markedly upon the amount of water available in the root zone. This suggests that some of the drought hazard can be removed by growing varieties of crops with extensive root systems and by using soil management practices to improve soil properties for optimum root growth. For example, the available water would be increased from 1 to 2 inches if the principal root occupancy zone were increased from 1 to 2 feet. Thus the number of drought-days would be reduced approximately 50 percent.

While crop varieties with more extensive root systems and soils with properties for better root growth would decrease drought occurrence, supplemental water will still be required in producing maximum yields. Numerous charts, graphs and tables are presented.

Agr. Expt. Sta., Ala. Polytech. Inst., Auburn, Ala.

Janes, B. E., and Drinkwater, W. O., IRRIGATION STUDIES ON VEGETABLES IN CONNECTICUT. Conn. (Storrs) Agr. Expt. Sta. B. 338, 82 pp. 1959.

The effects of irrigation on yield, quality and soil moisture extraction patterns of cabbage, beans, tomatoes, onions, lettuce and corn were studied from 1950 to 1954 on Merrimac fine sandy loam.

A prolonged condition of low soil moisture occurring any time in the growth of cabbage will reduce the yield. Dry conditions are most harmful if they occur during the later part of the growing season. The highest yields of cabbage were obtained when soil moisture in topsoil was maintained below a tension of 2 atmospheres. Changes in soil moisture at 6 to 8-inch depth as measured with gypsum moisture blocks were associated with growth of cabbage and can be used to indicate need for irrigation.

Of the six crops studied, beans were the most susceptible to injury from moisture stress. Greatest injury to beans from lack of moisture occurred in later stages of growth, but lack of moisture at any time reduced the yield. There was appreciable extraction of water from the 12-inch depth and possibly deeper but the largest portion of the water used by beans came from the top 8 to 10 inches of soil. Changes in soil moisture in the top 4 to 8 inches of soil can be used to indicate the need for irrigation of beans.

The only season in which irrigation had any effect on the yield of tomatoes was 1953. In 1950 there were more decayed fruit on the heavy-and-frequent treatment which received additional nitrogen than on the other treatments. In 1953 irrigation increased the size of tomato fruit. Cracking of tomatoes was associated with high soil moisture conditions. Tomato roots absorb water first from the topsoil and then from greater depths. The topsoil was found to be the most important source of water for tomato plants.

Accurate control of soil moisture is necessary to obtain maximum yield of high quality onions. High soil moisture tension, especially during periods of rapid growth resulted in small onions with poor keeping quality. Low soil moisture tension, especially late in the season, increased the number of defective onions and delayed maturity. Root distribution studies showed the maximum vertical penetration to be about 30 inches with most of the roots restricted to the top 7 inches and only a few roots below 12 inches. Changes in soil moisture at the 4- to 8- inch depth gave a satisfactory measure of the need for irrigation of onions.

Lettuce has a low moisture requirement, 3 to 7 inches of water, either from rainfall or irrigation, being sufficient to mature a crop of lettuce in Connecticut. Attempts to grow lettuce in the summer of 1952 and 1953 were unsuccessful. There was some evidence that irrigation would reduce the harmful effects of high temperature. The greatest benefits from irrigation of lettuce was obtained at time of planting fall crop.



Yield of corn was not influenced by irrigation in either 1950 or 1951. The indications were that low soil moisture tension during ear formation was beneficial. Overirrigation of corn may leach nitrogen and other soluble nutrients from the root zone, resulting in reduced yields. When sufficient moisture and nutrients are available close spacing of corn plants in rows results in high yields of marketable ears.

Storrs Agr. Expt. Sta., U. Conn., Storrs, Conn.

Kattan, A. A., Horton, B. D., and Moore, J. N. EFFECT OF SUPPLEMENTAL IRRIGATION ON YIELD AND QUALITY OF TWO VEGETABLE CROPS. Ark. Farm Res. 7 (3): 3. 1958.

## I. Sweet Potatoes

Although this crop is considered one of the most drought-resistant vegetable crops, studies in Arkansas indicate that it responds readily to irrigation.

Top yields were obtained when 1 1/2 acre inches of water were applied every 10 days. This treatment resulted in approximately 170 more bushels per acre than no irrigation. The effect of irrigation on yield was found to be due primarily to an increase in the number of storage roots produced per plant.

When the irrigation rate was increased to 1 1/2 acre inches a week, the yield was reduced. The reduction was accompanied by a sharp decline in potassium uptake and a tendency toward enzymatic discoloration. This may indicate that the higher rate of irrigation interferes with a high soil aeration requirement for this crop. Therefore, maintaining available soil moisture above 50 percent (recommended for most vegetable crops) should not be practiced with sweet potatoes.

Increasing yields through irrigation did not result in a sacrifice in quality of the canned product, provided conditions conducive to enzymatic discoloration were not allowed during the canning operation. Irrigated sweet potatoes showed a higher potential for discoloration, with the highest rate of irrigation resulting in the most severe tendency for discoloration. Therefore, when sweet potatoes are irrigated, available soil moisture in the upper foot should be allowed to drop to about 25 percent of available between irrigations.

To obtain the full advantage of higher yields from irrigating sweet potatoes, preheating should be considered as a standard processing operation, to eliminate the problem of discoloration.

## II. Tomatoes

In humid regions such as Arkansas, supplemental irrigation of processing tomatoes has been a controversial subject. In most cases the increase in yield has been accompanied by an increase in incidence of decay and radial cracking.

Research work conducted at this Station has shown that maximum returns from irrigating processing tomatoes can be obtained only when close spacing is also practiced. Maintaining available soil moisture above 50 percent and spacing the plants 18 inches apart in the row resulted in a substantial increase in yield.

The most important single factor in quality of processing tomatoes is color. The high summer temperatures in the South limit the development of red color (lycopene). Results of these studies indicated that fruits of superior color were obtained when irrigation and close spacing were practiced. The vigorous vegetative growth resulting from these practices protected the fruit from radiant heat.

Irrigation did lower the percentage of soluble solids in the fruit. However, this is a minor disadvantage, especially to the canners of whole tomatoes.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Irrigated and unirrigated whiteclover-pangolagrass pastures grown on Scranton loamy fine sand and fertilized liberally were grazed intensively with separate groups of lactating cows for a three-year period. Annual rainfall averaged 46.3 inches and an annual average of 24.8 inches of water was applied to the irrigated plots with an over-head sprinkler system.

From the beginning of grazing each year through May, clover was the principal forage, and after the first of June pangolagrass furnished practically all of the forage. Total digestible nutrients obtained from the pasture during clover grazing season averaged 2,544 pounds for the irrigated and 1,743 pounds for the unirrigated pasture. Production of total digestible nutrients from June 1 until termination of grazing, when pangolagrass was the primary forage, averaged 4,265 and 3,899 pounds for the respective pastures. There was an increase of 48.3 pounds of total digestible nutrients per acre-inch of water applied for clover and 44.1 pounds per acre-inch for that applied during the grass season.

Grazing began an average of 14.3 days earlier (March 5) on the irrigated pastures, but termination dates were the same on both. Cattle grazed the irrigated pasture continuously each year, but grazing was interrupted on the unirrigated once annually for an average period of 18.3 days.

Calculated production cost of the unirrigated pasture average \$80 per acre, or 1.41 cents per pound of total digestible nutrients produced, and net returns averaged \$140 per acre. The average application of 24.8 inches of water to the irrigated pasture was accompanied by an increase in returns above other production costs of \$53 per acre over that of the unirrigated, or \$2.13 for each acre-inch of water applied. The increase in returns above other production costs was \$2.43 per acre-inch for the 16.6 inches of water applied for clover and \$1.56 for the 8.2 inches applied during the grass season. These data indicate that under conditions favorable for the production of whiteclover or similar high-quality forages, returns per unit of irrigation water applied to them should be higher than for that used on pangola or similar permanent pasture grasses.

The Scranton loamy fine sand soil on which the experiment was conducted had a high water table which provided some reservoir to the pasture.

Total irrigation costs figures commonly used in Florida range from \$2 to \$3.50 per acre-inch of water applied to pasture by sprinkler systems and \$0.25 to \$0.75 per acre-inch applied by sub-irrigation systems. According to these figures, the increase in average net returns from irrigation of whiteclover-pangolagrass pasture under the conditions of this experiment would be marginal for the most efficient sprinkler type operations. If a comparable increase in net returns per acre-inch of water applied were obtained by sub-irrigation, the practice would be economical on land suitable for sub-irrigation.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Myers, J. M., and Clark, F. IRRIGATE TOBACCO ON SCHEDULE. Fla. Agr. Expt. Sta. C. S-104, 11 pp. 1958.

Irrigation water should be applied when it is needed, where it is needed, and in the proper amount. It is needed only when a large percentage of available soil moisture has been removed from the active root zone. The only exception to this is when plants are being established in the field. Water should be applied only to a depth commensurate with root penetration and in an amount sufficient to replace the accumulated moisture deficit.

In order to avert the economic losses associated with inadequate or poorly distributed rainfall, install and use an irrigation system to add moisture when rainfall does not provide it, and apply irrigation water at the right time and in the correct amount to overcome the soil moisture shortage without contributing to nutrient leaching.

The size of application should be increased gradually from 0.3 inch to about 0.6 inch by the end of the fifth week after transplanting. After the fifth week all applications should be about 0.9 inch. This is a general rule and applies only when tobacco is grown in soils such as Lakeland fine sand. If the soil is a "heavier" type, the length of time between



applications and the amount of water per application should be increased. The opposite is the case when tobacco is grown on a "lighter" soil; the interval between irrigations should be shorter and the amount of water per irrigation less.

Irrigation must be blended with other good cultural practices for highest profits. Fertilization is among the more important of the other cultural practices. Good results have been obtained by many growers of irrigated tobacco by employing the same rate of fertilization that they used prior to the use of irrigation; while others have found it more profitable to increase this amount by 10 to 20 percent. The practice of splitting the fertilizer application so that half is placed in the soil before transplanting and half to the side three weeks after transplanting has proven profitable, in conjunction with irrigation.

Irrigation can be a very important factor in controlling the growth environment and thereby have a material effect upon the quality of tobacco produced.

U. Fla. Agr. Expt. Sta., Gainesville, Fla.

Spooner, A. E., Brown, D. A., and Waddle, B. A. EFFECTS OF IRRIGATION ON COTTON FIBER PROPERTIES. Ark. Agr. Expt. Sta. B. 601, 27 pp. 1958.

This bulletin reports the effects of irrigation and nitrogen levels on the length, strength, and fineness of cotton fiber at four locations in Arkansas for the 1955, 1956, and 1957 seasons.

The results from these tests can be summarized as follows:

FIBER LENGTH--In general, adequate moisture applied by irrigation increased fiber length significantly over non-irrigated conditions.

FIBER STRENGTH--Adequate moisture applied by irrigation had no effect on fiber strength except at one location where it was significantly decreased.

FIBER FINENESS--At most locations, proper moisture conditions produced fibers that were more uniform and better matured. There appeared to be an inverse correlation between fiber length and fineness.

Nitrogen levels had no significant effect on the fiber qualities measured.

One general conclusion may be drawn from this work. Proper irrigation does not lower fiber quality; instead it stabilizes and, in most cases, improves the quality of cotton produced.

Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

Robins, J. S., and Rhoades, H. F. IRRIGATION OF FIELD CORN IN THE WEST. U. S. D. A., L. 440, 8 pp. 1958.

Irrigation of field corn has been practiced for many years in arid and semiarid regions. It helps farmers grow corn on land that would otherwise be unproductive. In fact, proper irrigation in these regions contributes as much to high corn yields as proper selection of adapted varieties or adequate fertilization.

The factors that should be considered when corn is irrigated in the west are described. The rate of application and frequency of irrigation is governed by the type of soil, climatic conditions and growth stage of the crop throughout the growing season.

ARS, USDA, Inform. Div., Washington 25, D. C.

Jamison, V. C., and Beale, O. W. IRRIGATING CORN IN HUMID REGIONS. U. S. D. A., Farm. B. 2143, 16 pp. 1959.

Corn growers in arid and semiarid regions irrigate at regular intervals during the growing season. Their irrigation schedules are seldom complicated by the fact that heavy rains may fall. Sometimes they find it feasible to apply preplanting irrigations to reduce the danger of early crop failure. In areas of low rainfall, germination is not possible without preplanting irrigation.

Irrigation of corn in humid regions is intended to supplement rainfall. It is seldom necessary or profitable to irrigate at regular intervals during the entire growing season. Growers usually maintain their irrigation systems on a standby basis and use them to carry their crops through critical periods of growth if drought occurs.

Preplanting irrigations in humid regions are usually unnecessary. Abundant rains during the winter and early spring generally fill the soil reservoir by planting time.

This Farmers' Bulletin gives general guides as to: Why irrigation helps; when to irrigate; methods of irrigation; and making irrigation pay.

Irrigation Guides for each State, compiled by the Soil Conservation Service, United States Department of Agriculture, are excellent sources of technical information for developing and operating irrigation systems.

ARS, USDA, Inform. Div., Washington 25, D. C.

Bryan, B. B., and Thomas, E. L., Jr. DISTRIBUTION OF FERTILIZER MATERIALS APPLIED THROUGH SPRINKLER IRRIGATION SYSTEMS. Ark. Agr. Expt. Sta. B. 598, 12 pp. 1958.

Results of six tests made at the Agricultural Experiment Station to evaluate the effectiveness of two systems for introducing fertilizer materials into solution in irrigation water applied with a sprinkler system are presented. Three solid, water-soluble, nitrogen-source materials were used.

Both the auxiliary pump and the closed tank systems may be used to inject the fertilizer into solution in water being applied through a sprinkler system. While the auxiliary pump system was found to result in a more uniform concentration of the fertilizer material distributed over the area, the closed tank system was found to produce the same concentration of fertilizer elements in the solution passing through all sprinklers on a lateral line.

Ordinary, water-soluble fertilizers may be applied successfully through sprinkler irrigation systems.

A reasonably uniform concentration of fertilizer elements resulted from distributing soluble fertilizer through a sprinkler irrigation system. For practical purposes it may be assumed that the fertilizer materials will be applied to the soil as uniformly as is the irrigation water.

Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

Hill, D. E. THE STORAGE OF MOISTURE IN CONNECTICUT SOILS. Conn. Agr. Expt. Sta. B. 627, 30 pp. 1959.

The ability of soils to store moisture and release it for the use of growing plants is a primary determinant of the agricultural value of land. A survey of the storage abilities of Connecticut soils is described. This knowledge is especially useful in irrigation practices.

Successful irrigation practices call for knowledge of the moisture requirements of the plant, the nature of the root system, and the capacity of the soil to store moisture in the root zone and to release it effectively.

The present study deals with the third consideration: the moisture storage capacities of soils common to Connecticut, the physical conditions which effect moisture storage and release, and methods which may be used in readily estimating the storage and release characteristics for irrigation operations. The soils chosen for study were selected to include not only the important agricultural soils but also the wide range in soil textures found in the state.

Conn. Agr. Expt. Sta., New Haven, Conn.

Agriculture Research Service. USE OF BRACKISH WATER. U.S.D.A., Agr. Res. 8(6): 15. 1959.

Many crops can be saved during droughts by irrigation with brackish water in coastal areas where the sea has flooded into surface water sources or infiltrated wells. Brackish water is usable for crop production when it's a tenth to an eighth as salty as sea water, USDA research shows.

Virginia studies show an accumulation of salts in the top 6 to 12 inches of soil where brackish water has been used, but the following winter's rains usually wash them out.

Asparagus, spinach, garden beets, barley, sugar beets, and cotton are salt tolerant--tomatoes, sweet corn, lettuce, onions, rye, wheat, oats, soybeans and the cabbages are fairly so.

Growers faced with using brackish water should make arrangements for analysis of the salt content through their County Agricultural Agents or Soil Conservation Service personnel, to insure safe and effective use.

SWCRD, ARS, USDA, Washington 25, D. C.

Babcock, K. L., Carlson, R. M., Schulz, R. K., and Overstreet, R. A STUDY OF THE EFFECT OF IRRIGATION WATER COMPOSITION ON SOIL PROPERTIES. Hilgardia 29: 155-164. 1959.

All waters used to irrigate plants contain dissolved salts. Thus, if irrigation water is repeatedly evaporated and transpired by plants in a given mass of soil, the salt content of the soils will increase until it eventually becomes injurious to plants. Extensive research has been done on the amount of leaching necessary to prevent such salt accumulation, and on related problems.

Lysimeter experiments designed to study the quality of irrigation waters were initiated in 1953. The principal objective was to observe the effects of Na and  $\text{HCO}_3$  in the water on the chemical properties of the soil. After being cropped to alfalfa for four years, the soil was found to have significant salt gradients with depth. In many cases, there was an appreciable formation of exchangeable Na, and "excess cation saturation" had been induced. Extensive chemical analyses are reported.

Calif. Agr. Expt. Sta., U. Calif., Berkeley, Calif.

Mech, S. J. SOIL EROSION AND ITS CONTROL UNDER FURROW IRRIGATION IN THE ARID WEST. U.S.D.A., Agr. Inform. B. 184, 6 pp. 1959.

Soil erosion presents the greatest potential threat to the maintenance of productivity. Water and soil fertility are usually thought of as renewable resources, but surface soil that is eroded is only slowly renewable. In certain cases, eroded soil is practically impossible to restore.

On irrigated lands, erosion has not been considered important, as irrigation is carried out principally in areas of low rainfall. Yet, where sloping lands are irrigated by any method, erosion may occur as a result of the applied water moving across the soil.

Erosion on furrow-irrigated land can be serious. You can reduce it by (1) Decreasing the length of irrigation run, (2) Irrigating on the contour wherever practical, (3) Regulating the flow into furrow with control devices, (4) Paying special attention to the first irrigation, (5) Irrigating less frequently, and (6) Reducing cultivation to a minimum.

ARS, USDA, Inform. Div., Washington 25, D. C.

Code, W. E. FARM IRRIGATION STRUCTURES. Colo. Agr. Expt. Sta. B. 496-S, 60 pp. 1957.

The purpose of this bulletin is to help the farmer (1) build irrigation structures; and (2) estimate sizes where engineering assistance is not readily available.

The sizes and character of the structures discussed are limited to those used on the farm where water quantities seldom exceed six cubic feet per second. Structures of unusual character--including long span flumes and those structures involving high velocities in any open channel--should be built only with competent engineering advice. Tables for flow in open channels and in pipes are limited purposely to the ordinary conditions likely to be encountered on a farm.

Colo. State U. Expt. Sta., Fort Collins, Colo.



Robinson, A. R. FILTERS AND SCREENS FOR IRRIGATION WELLS. U. S. D. A., L. 446, 8 pp. 1959.

The properly designed irrigation well supplies water at a required rate and is relatively trouble free in operation. It provides a constant flow of water without excessive drawdown and without sand pumping. Filters and screens help satisfy these requirements.

A filter is gravel or sand screened to a size that holds back the sand in the water-bearing formation.

A screen is a perforated casing between the filter and the pump column. Its function is to permit water to flow into the well with the least interference and to keep the filter material from moving into the well.

The article tells and illustrates when a filter is needed, what size a filter material to use with each type of formation material and the size of filter material for each type of filter material for each type of formation material.

ARS, USDA, Inform. Div., Washington 25, D. C.

Houston, C. E., and Scott, V. H. MEASURING IRRIGATION WATER. Calif. Agr. Expt. Sta. C. 473, 53 pp. 1959.

Some of the most common devices and methods of measuring water are described. Drawings, tables, and charts to help determine rate of flow are presented. Some advantages and limitations, but it is impossible to mention all that may apply to any given situation. In fabricating, installing, operating, and maintaining water-measuring devices, follow recommended procedures, or gross errors in measurement may result. The illustrations show the general types of equipment, and are not construction drawings.

Calif. Agr. Expt. Sta., Ext. Serv., Berkeley 4, Calif.

Robinson, A. R., and Rohwer, C. MEASURING SEEPAGE FROM IRRIGATION CHANNELS. U. S. D. A., A. R. S. Tech. B. 1203, 82 pp. 1959.

Many factors are known to have a definite effect on seepage rate, the principal ones being characteristics of the soil of the canal bed, length of time the canal has been in operation, depth to ground water, amount of sediment contained in the water, depth of water in the canal, temperature of the water and of the soil, percentage of entrained air in the soil, capillary tension in the soil, and barometric pressure. Biological factors influence the seepage rate in greater or lesser degree. Salts contained in the soil or water affect the rate in some instances. Since all the factors act simultaneously, and some of them tend to counteract each other, it is difficult to segregate the effect of any one of them. Because of the many variables involved and the complexity of their relations, no satisfactory formula for computing seepage has ever been developed.

ARS, USDA, Inform. Div., Washington 25, D. C.

## Drainage

Blosser, R. H. DRAINAGE HELPS TO GET BEST RESULTS FROM FERTILIZER. Ohio Farm and Home Res. 44: 57. 1959.

Profits from fertilizer are influenced by many factors. Some of the most important ones include rate of application, soil type, past land management, soil drainage, amount of rainfall, time of planting crops, plant population, crop varieties used and control of weeds, insects and plant diseases.

A study of crop yields on Paulding soil in northwestern Ohio shows that drainage is poor on this soil because of the level topography. Drainage through tile is slow because of the clay content that ranges from 60 to 80 percent.

Yields of corn and oats show how drainage affected the response from certain applications of fertilizer. These yields are averages for the three-year period, 1954-56. Fertilizer rates are in terms of a 3-12-12 analysis.

Average Yield of Corn and Oats Per Acre

Crop	Fertilizer per acre	Drainage rating		
		Below average	Average	Above average
Corn	Pounds	Bushels	Bushels	Bushels
	0	45	50	57
	150	48	56	64
	300	49	62	71
Oats	450	--	57	77
	0	27	31	77
	200	31	36	42
	300	32	40	47

Ohio Agr. Expt. Sta., Wooster, Ohio

Goins, T., and Taylor, G. S. DRAIN DEPTH AND SPACING EFFECTS ON WATER REMOVAL FROM A GRAY-BROWN PODZOLIC SOIL. Soil Sci. Soc. Amer. Proc. 23: 413-417. 1959.

The effect of two depths and two spacings of drains on tile flow rates and drawdown in a glaciated Ohio soil (Nappanee silt loam) were evaluated. Drain depths were 2 and 3 feet, and the spacings were 30 and 60 feet.

Flow rates were linearly related to the water table (WT) level at the midpoint between drain lines. Tile flow was more closely related to the position of the WT in the profile than to the height of the WT above the drain, indicating the strong influence of the conductivity profile in drainage. The highest flow rates were obtained from drains at the 2-foot depth; while spacing had no significant influence on maximum flow rates. Drains at the 2-foot depth lowered the WT faster in the upper 18 inches of soil than did those at the 3-foot depth; and drains spaced 30 feet apart were more effective in lowering the WT than those spaced 60 feet. The relative performance of the drains at 2- and 3-foot depths was a result of decreased soil hydraulic conductivity with depth.

Estimates of soil hydraulic conductivity based on drain flow and WT levels showed that the auger hole and the O'Neal methods underestimated the conductivity by factors no smaller than 4 and 2, respectively.

Ohio Agr. Expt. Sta., Wooster, Ohio.

Evans, N. A. STRATUM SURVEY TECHNIQUES FOR DRAINAGE INVESTIGATION ON IRRIGATED LANDS. Colo. Agr. Expt. Sta. Tech. B. 67, 19 pp. 1958.

The purposes of this bulletin are to: (1) discuss briefly the techniques and equipment for making stratum surveys by three boring methods, and (2) to discuss in detail the use of a geophysical method. The latter discussion is intended to encourage the use of this technique by drainage engineers in making substratum investigations for drainage of irrigated lands. The section on theory contains a discussion of this technique which will be of interest but not essential to the application of the method.

Colo. State U. Expt. Sta., Fort Collins, Colo.

Childs, E. C. A TREATMENT OF THE CAPILLARY FRINGE IN THE THEORY OF DRAINAGE. J. Soil Sci. 10: 83-100. 1959.

The hodograph treatment of the problem of drain design, as developed by van Deemter, is suitably modified to take into account the presence of a capillary fringe above the water table. Examples are presented to show that the presence of the fringe requires

an increase of optimum drain size, and that thick fringes are accommodated mostly above a water table which is not proportionately much depressed below that which is appropriate to an absence of fringe, while thin fringes are accommodated in approximately equal proportions above and below the level of the fringeless water table.

Sch. Agr., Cambridge; England.

Edelman, C. H., and Staveren, J. M., Van. MARSH SOILS IN THE UNITED STATES AND IN THE NETHERLANDS. J. Soil and Water Conserv. 13: 5-17. 1958.

This paper is a report of a trip to the United States made by the authors at the invitation of the Soil Conservation Service. The object of the trip was to look at the marsh soils and to assess--in light of Dutch experience--the possibility of reclaiming them. They conclude:

1. There are large complexes of humic-sandy and loamy-sandy profiles, sometimes with a wild vegetation but mostly covered with trees, which would be very suitable for use as improved pasture and also for truck crops, provided that there is properly controlled water management. These reclamations should not be expensive due to the higher elevation above mean sea level.

2. The peat soils should be considered secondarily attractive, with preference for those with a sandy subsoil. Careful water control is essential for the conservation and continued good productivity of these soils. This is even more important here than in the case of the first group. For various reasons the reclamation will turn out a little more expensive than for those in group 1.

3. Vast areas of low-lying loamy-clay and clay soils occur. Since these do not possess the unfavorable properties of group 4, reclamation must be considered quite possible. This land is suitable for row cropping as well as pasture. Owing to the lower situation, resulting in more expensive dike construction, and to the intensive drainage and desalting which are necessary, the reclamation costs are fairly high for this group.

4. On various occasions clay soils were observed which, because of their high content of sulphides, showed the unfavorable pattern of cat clays. No attempt should be made to reclaim these soils. Cultivation would be too expensive. Cat clay can be allocated as wildlife refuges.

International Inst. for Land Reclam. and Impr., Wageningen, Holland.

Coleman, W. J. STATE-COUNTY-LOCAL COOPERATION UNDER DELAWARE DRAINAGE LAWS. U. S. D. A., A. R. S. 43-98, 40 pp. 1959.

This report presents a comparison and evaluation of various provisions of the existing drainage laws of Delaware, considers the State's experience in creating, financing, and managing certain selected drainage organizations, and relates these statutory provisions and experience to the qualifications of a Delaware tax ditch (a drainage organization) to act as a sponsor or cosponsor of a watershed project under the Federal Watershed Protection and Flood Prevention Act of 1954 (Public Law 566), as amended in 1956 (Public Law 1018) and 1958 (Public Law 85-624; Public Law 85-865).

ARS, USDA, Inform. Div., Washington 25, D. C.

## BASIC SOIL PROBLEMS

### Soil Structure

Kawano, Y., and Holmes, W. E. COMPACTION TESTS AS A MEANS OF SOIL STRUCTURE EVALUATION. Soil Sci. Soc. Amer. Proc. 22: 369-372. 1958.

Compaction test data from the surface horizons and subsoils of 15 soils were analyzed to evaluate the most suitable data for correlations with percent carbon and percent clay. Percent pore space at maximum bulk density when correlated with either percent carbon or percent clay yielded correlation co-efficients of greater statistical significance than did maximum bulk density when so correlated. This is probably because of the



variations in particle (mineral) densities of the soils investigated. The particle densities will to some extent influence the maximum bulk densities attained with any compaction test, but percent pore space at maximum bulk density is not so influenced. It was concluded that unless the soils undergoing investigation have essentially the same particle densities, percent pore space at maximum bulk density is a better choice of data for correlation studies than is the maximum bulk density.

Percent pore saturation at maximum density was not found to be a suitable correlation variable. A statistically highly significant correlation coefficient was obtained when optimum moisture (standard Proctor test) was correlated with plastic limit.

Compaction test data from 5 montmorillonitic clay soils were compared to those from 5 kaolinitic clay soils. These comparisons failed to indicate that the montmorillonitic clay soils were more susceptible to compaction from mechanical forces than were the kaolinitic clays. Montmorillonitic clays did, however, have significantly higher liquid limits and plastic indices.

Hawaii Agr. Expt. Sta., Honolulu, Hawaii.

Flocker, W. J., Vomocil, J. A., and Vittum, M. T. RESPONSE OF WINTER COVER CROPS TO SOIL COMPACTION. Soil Sci. Soc. Amer. Proc. 22: 181-184. 1958.

Some soils can be easily compacted as a result of their structural and textural composition. Observations indicate that soils of the Yolo series can be compacted markedly with sufficient manipulation and pressure. Operating a tractor and a loaded jeep over this field changed bulk density of the surface soil from 1.22 to 1.58.

The effect of this compaction manifested itself in lowered infiltration rates, increased cloddiness, increased clod density, increased cohesion of the clods, and reduced stands and yields of cover crops. The increased cloddiness adds greatly to the cost of tillage operations, especially when a fine seedbed is required for small-seeded crops.

In the present experiment, sod grasses reduced soil moisture nearer to the optimum for tillage than did the other crops, and did so more rapidly. Purple vetch was almost as effective at the greatest depth, but this legume did not improve infiltration of water into the soil. Sod grasses, on the other hand, permitted the highest infiltration rate. Further investigation is needed of the effect of added organic matter on degree of cloddiness, clod density, cohesion of clods, and improvement of soil structure in general.

Charts and graphs.

U. Calif., Berkeley, Calif.

Smith, R. M. SOME STRUCTURAL RELATIONSHIPS OF TEXAS BLACKLAND SOILS, WITH SPECIAL ATTENTION TO SHRINKAGE AND SWELLING. U. S. D. A., A. R. S. 41-28, 51 pp. 1959.

The purpose of this study was to increase the understanding of structural behavior of fine-textured soils, especially as they occur in the Blacklands of Texas. The starting point is natural soil structure as observed in the field under variable land use or treatment. Since shrinkage and swelling with changes in moisture constitute an outstanding physical characteristic of Blackland soils, this has been the primary factor considered. An attempt has been made to find out how much and under what conditions different soils or materials shrink or swell. By means of mechanical alterations, chemical treatments, and theoretical considerations some evidences have been brought out as to the cause of observed or measured results. Texture, lime content, exchangeable cations, organic matter, and clay mineral type are the main factors which have been considered along with mechanical treatments and moisture, expressed in terms either of volume or of moisture tension.

ARS, USDA, Inform. Div., Washington 25, D. C.

Alov, A. S. PLANT NUTRIENTS IN STRUCTURED SOILS. Soviet Soil Sci. 3: 327-333. March, 1958.

The concept that structured soils have a better nutrient status than structureless soils is inadequately supported by experimental data. In general, this concept is based on the fact that structured soils have more favorable air and moisture properties which encourage intensification of microbiological activity. According to this concept, structured soils have a more harmonious combination of aerobic and anaerobic decomposition of organic matter, which also affects the optimal nutrient conditions for plants.

The material used was the ordinary low-humus chernozem of the Bezenchuk Experimental Station. A differentiated study was made of the unique characteristics of the nutrient conditions of its individual structural fractions and the reaction of plants to these characteristics.

The author makes the following conclusions:

1. The fertility of structured soil is not uniform. With an increase in the size of clods (after drying and remoistening) there is a decrease of the most available forms of nutrients for plants--nitrates, phosphorus and potassium; an increase in their ammonia content (in clods up to 5 mm. in diameter); and an increase in the total adsorbed cations and degree of saturation with these cations in the larger clods as hydrolytic acidity decreases.
2. Differences in the quality of clods of different sizes cause an uneven degree of fertility and, under the conditions of the pot experiment, dried and remoistened pulverized soils assure better initial growth of plants than do structured soils. The coarser the structure of the aggregate, the weaker the initial growth of the plant.
3. With adequate moisture in the pot experiment, structured soils from the beginning of tillering show intensified mobilization of the available plant nutrients, primarily nitrogen, and the development of plants on them improves noticeably. The smaller the size of the structural aggregates, the earlier the mobilization of nutrients occurs. The finer clods give a larger yield of grain and straw and more full-weight grain than do the coarser clods. As the clods become coarser the number of shoots at tillering increases, maturity is delayed and the growing period increased.
4. When structured soils are left in fallow in the presence of adequate moisture and the absence of overdrying of the clods their nutrient content improves considerably and the initial growth of plants on them is the same as on pulverized soils.

Amer. Inst. of Biol. Sci., 2000 P St., N. W., Washington 6, D. C.

## Soil-Water Relationships

Bierhuizen, J. F. SOME OBSERVATIONS ON THE RELATION BETWEEN TRANSPIRATION AND SOIL MOISTURE. Netherlands J. Agr. Sci. 6: 94-98. 1958.

Pot experiments on transpiration with kidney beans (*Phaseolus Vulgaris*) were carried under controlled conditions of light intensity and temperature. Transpiration was measured by loss of weight. Measurements were taken at different moisture contents from the field capacity down to the wilting point. From the regularly recorded data on loss of weight, the moisture content at each interval was calculated. The transpiration rate is greatest at higher light intensities. It increases with the increase in the available moisture content from the wilting point and then becomes more constant at higher levels of moisture availability. At the highest light intensity it shows a maximum beyond which it slightly decreases. This may be explained by the deficiency of oxygen at high moisture contents.

Inst. Land and Water Mangt. Res., Wageningen, Netherlands.



It was established that the amount and rate of water infiltration are affected not only by the soil texture but also by a number of factors which are difficult to calculate, such as initial soil moisture, plant cover, bulk density of soil, its porosity, the presence in the soil of organic residues, cracks, worm holes and the roots of grassy plants, the soil structure, and so forth. The effect of tillage on the water intake into soil has not yet been sufficiently elucidated in the literature. For the last few years (1949 to 1956), we have been making a study of water intake into soil in both winter and summer. With the Nesterov apparatus containing a constant depth of 5 cm. of water, determinations were made of the total water intake in millimeters and the rate of water intake with different agricultural practices (millimeters per minute).

The experiments were carried out on the Kamennaya Steppe irrigated crop rotation fields of the Dokuchayev Institute of Agriculture. The crop rotation was located on the slope of a northeastern exposure. The soil of the tract was uniform and consisted of ordinary chernozem 0.6 to 0.8m. (24"-32") thick underlain by deposits of clay loam.

The authors made the following conclusions:

1. Chernozem soils are very permeable to water.
2. Both the amount and rate of water intake by soils is influenced by structure, tillage, and the looseness of the soil. The better the structure of the upper horizon of the soil, the higher the total amount and rate of water intake.
3. The soil moisture (or lack of it) also exerts an effect on water intake, but this influence is usually more significant in the water intake by frozen soil than in that by thawed soil in summer.
4. The lowest intake rate in summer was observed on rotation pasture and fallow. Pasturing cattle and excessive plowing of the land causes puddling of the soil and a decrease in its permeability to water. Grass sowings restore the soil structure and a sharp increase in its permeability to water when the grass is plowed up.
5. A crust of ice on the soil surface in winter considerably decreases the water intake on all farm lands, including fall-plowed land.
6. Since the water intake by the soil depends strongly on the agricultural engineering practices on the fields, it is possible by proper soil tillage to obtain an increase in moisture in the fields by absorption of the spring snowmelt.

Amer. Inst. of Biol. Sci., 2000 P. St., N. W., Washington 6, D. C.

Gardner, W. R. SOME STEADY-STATE SOLUTIONS OF THE UNSATURATED MOISTURE FLOW EQUATION WITH APPLICATION TO EVAPORATION FROM A WATER TABLE. Soil Sci. 85: 228-232. 1958.

A transformation is given which makes possible the exact solution of some steady-state unsaturated-flow problems and approximate solution of some transient problems. Solutions of the steady-state problem in one dimension are given for several different relations between capillary conductivity and soil suction.

Steady-state evaporation from a soil having a water table is examined. The maximum evaporation rate is shown to be related to the capillary conductivity and depth to water table in a simple fashion. It is concluded that movement of water in the vapor phase is relatively unimportant in this connection. The influence of a surface mulch is also considered.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Gardner, W. R., and Fireman, M. LABORATORY STUDIES OF EVAPORATION FROM SOIL COLUMNS IN THE PRESENCE OF A WATER TABLE. Soil Sci. 85: 244-249. 1958.

The experimental rates of evaporation of water from laboratory soil columns have been compared with the theoretical solutions of the steady-state unsaturated moisture-flow equation. Good agreement between theory and experiment was found. The evaporation

rate is determined by climatic factors which control the external potential evaporation or by the maximum rate of upward movement of water in the soil, whichever is the lesser.

The evaporation rate is shown to be inversely proportional to the thickness of a surface mulch when the rate of vapor movement through the mulch is less than the potential evaporation.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Jamison, V. C., and Kroth, E. M. AVAILABLE MOISTURE STORAGE CAPACITY IN RELATION TO TEXTURAL COMPOSITION AND ORGANIC MATTER CONTENT OF SEVERAL MISSOURI SOILS. Soil Sci. Soc. Amer. Proc. 22: 189-192. 1958.

Fifty-four profiles of twenty-one "predominately silty" Missouri soils were studied. Undisturbed cores were taken with modified Lutz Samples for suction, bulk density and field moisture measurements. Available moisture holding capacity, organic matter content, and mechanical composition were determined. These studies show that for these dominantly silty soils available moisture storage capacity (A.W.C.) decreases with clay and increases with silt content. Coarse silt (0.05 to 0.02 mm.) increases A.W.C. more than fine silt (0.02 to 0.002 mm.). A.W.C. also increases generally with organic matter content but since organic matter increases with coarse silt and decreases with clay the effect can be attributed to textural changes. The silt-rich surface is higher in organic matter and A.W.C. than the clay-rich subsoil (particularly the clay pans). Only in a grouping of samples between 13 and 20% clay is there evidence that organic matter may improve storage, possibly by forming silt sized microaggregates in the clay. This effect is not apparent in soils dominated by fine textural components and relatively low in organic matter.

Mo. Agr. Expt. Sta., Columbia, Mo.

Lund, Z. F. AVAILABLE WATER-HOLDING CAPACITY OF ALLUVIAL SOILS IN LOUISIANA. Soil Sci. Soc. Amer. Proc. 23: 1-3. 1959.

A water-holding capacity survey consisting of 22 profiles in Louisiana gave a positive correlation of 0.626 for silt and range of available moisture. Data indicated clay held moisture at suction values too high for plant availability. A negative relationship existed between sand and range of available water. Permeability was positively correlated with percent large pores.

Many of the soils of Louisiana range from medium to fine texture and have large amounts of water available to plants. Permeability is a problem due to the low percent large pores.

SWCRD, ARS, USDA, Louisiana State U., Baton Rouge, La.

Blaney, H. F., and Muckel, D. C. EVAPORATION FROM WATER SOURCES IN CALIFORNIA. State Calif. Dept. Water Resources, Div. Resource Planning B. 73, 92 pp. 1959.

For many years, the State Department of Water Resources, and its predecessor agencies, have cooperated with the United States Department of Agriculture in study and research on the subject of evaporation from water surfaces in California.

This report includes the records from 1881 to 1954 published by the State Division of Water Resources in Bulletins Nos. 54, 54-A and 54-B entitled "Evaporation from Water Surfaces in California" and records for the period 1954 to 1958.

Dept. Water Resources, State Calif., Sacramento 5, Calif.

Dettmann, M. G. WATER UPTAKE BY PURE CLAYS AND SOIL CRUMBS. J. Soil Sci. 9: 306-315. 1958.

Wetting experiments on pure clays are described that lead to the conclusions that entrapped air is neither a necessary nor an important factor in slaking of dry soils, and that slaking is always associated with rapid intercrystalline swelling of the clay. If

swelling is suppressed, or takes place slowly--as from a vapor phase--slaking does not occur, and it is suggested that slow swelling gives time for readjustment of the internal geometry of the clay, so producing some dislocation but no disruption. In N NaCl, a Na-montmorillonite swells to about twice its dry thickness, and in an atmosphere of 98 percent relative humidity it gains about one-third of its weight. Both these figures are in agreement with the usual estimate of surface area of 800 M<sup>2</sup>/g. Under the same conditions a Na-illite (from Willalooka) swells by about a third of its dry thickness, and gains about a quarter of its dry weight.

Studies on rates of uptake of water vapor indicate that montmorillonite has taken up less than a quarter of its equilibrium water content at 98 percent relative humidity within 10 min., whereas illite has taken up one-third of its water in the same time, the clays then being stable against subsequent flooding.

In the field it is probably that water vapor diffuses ahead of a liquid wetting front, and the protective effect of the resultant slower pre-swelling of the clay prevents the slaking action of rain from affecting more than a thin surface layer of soil.

Rothamsted Expt. Sta., Harpenden, England.

## Lime

Whittaker, C. W., Anderson, M. S., and Reitemeier, R. F. LIMING SOILS AN AID TO BETTER FARMING. U.S.D.A., Farm. B. 2124, 32 pp., illus. 1959.

The use of lime on acid soils is a major step toward better farming.

Lime corrects soil acidity, supplies calcium, improves the availability of some other plant nutrients, and increases the efficiency of fertilizers and manures. It promotes desirable biological activity and improves the structure of certain acid soils.

Liming facilitates the production of green manures and cover crops. Proper liming combined with other desirable soil-management practices usually brings increased yields of better crops.

This bulletin describes why and where limestone is needed along with the proper use of the different kinds of liming materials and how they may be applied.

ARS, USDA, Inform. Div., Washington 25, D. C.

Foy, C. D. ACID SOILS DIFFER IN THEIR TOXICITY TO ALFALFA. Ark. Farm Res. 8(5): 5. 1959.

Investigators do not agree on the reason plants make poor growth in acid soils. The cause seems to vary with soil type and plant species. Among factors that have been suggested are unavailability of calcium and phosphorus, and toxicity of hydrogen, aluminum, manganese, and iron.

In a greenhouse experiment four acid Arkansas soils differed widely in their ability to produce alfalfa under conditions of high phosphate and potash and adequate boron.

At pH values below 6.0, yields varied widely on the four soils.

Liming all soils to a pH of about 6.0 (which produced most of the yield increase due to lime) reduced levels of extractable aluminum and exchangeable manganese, and increased levels of exchangeable calcium.

Differences in levels of extractable aluminum do not adequately explain wide yield differences between acid soils with equal pH values.

Yield increases obtained by liming appear to be more closely related to decreases in exchangeable manganese and increases in calcium saturation than to decreases in extractable aluminum.

SWCRD, ARS, USDA, Fayetteville, Ark.

Koegh, J. L., Noggle, J. C., Maples, R., and Beacher, R. L. LIMING COTTON SOILS. Ark. Farm Res. 7(2): 12. 1958.

The use of lime for crops other than hay and pasture has become increasingly important. Results of soil tests have shown that many cotton soils are getting into a critical pH range--that is, 5.5 and less.



In 1955 a study was begun at the Cotton Branch Station to study this problem. The pH of the soil was originally 5.0. The experiment consisted of two treatments, lime and no lime, replicated four times. The lime was applied at the rate of 2 1/2 tons per acre in late winter of 1955 and disked into the soil. Cotton has been planted each year since, with a cover crop of vetch in the winter.

There was a marked difference in the amount of vetch growth resulting from the lime treatment. Vetch in the unlimed areas made little or no growth, while in the limed areas growth was good to excellent.

Cotton was subjected to adverse weather in 1955. The unlimed areas showed marked increase in seedling diseases with resulting decrease in stand. On late-planted cotton, such as the 1957 crop, this difference in stand was not as apparent. At even very young stages of growth there was a marked difference in growth and color. The cotton in the limed plots was taller, fuller and darker in color.

"Crinkle leaf," which is due to manganese toxicity resulting from low pH, was evident in some of the unlimed plots each year.

In 1955 there was an average increase in seed cotton of 797 pounds due to lime. The increase of only 71 pounds in 1956 was not significant. In 1957 the increase of 409 pounds was highly significant. For the three years the average annual increase was 426 pounds per acre.

Soil samples were taken at regular intervals to follow the change in pH after liming, as well as effects on calcium and magnesium levels. The pH showed a gradual increase during 1955, the year the lime was applied, and continued to rise slowly through 1956 and 1957.

It can be seen that each year there was a wider spread in pH, calcium, and magnesium between the limed and unlimed areas. It appears that the pH is approaching its maximum, as the change during the last year was small. Judging from this and similar studies, we can expect continued good returns from one application of lime.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

## Soil Chemistry

AGRICULTURAL AND FOOD CHEMISTRY. Soil Sci. 85: 59-116. 1958.

This February issue of Soil Science contains the papers presented under the auspice of the Division of Agricultural and Food Chemistry, American Chemical Society, in Miami, Florida, April 9 and 10, 1957. The subjects and authors are as follows: Mechanisms of Trace Element Function, George K. Davis; The Function of Metals in Enzyme Systems, Alvin Nason; Role of Trace Elements in Electron Transport and Oxidation Phosphorylation, F. L. Crane; Occurrence of Mineral Deficiencies and Toxicities in Animals in the United States and Problems of Their Detection, E. S. Thacker and Kenneth C. Beeson; Some Spectrographic Studies of Trace Element Storage in Human Tissues, R. E. Nusbaum, G. V. Alexander, E. M. Butt, T. C. Gilmour, and S. L. Didio; Comparative Metabolic Studies in Inorganic and Heme-Complex Forms of Copper in Rats and Sheep, C. F. Mills; and Trace Elements in Poultry Nutrition--A Review, A. A. Kurnick, B. I. Reed, and J. R. Couch.

Lynch, D. L., Wright, L. M., Hearn, E. E., and Cotnoir, L. J., Jr. SOME FACTORS AFFECTING THE ADSORPTION OF CELLULOSE COMPOUNDS, PECTINS, AND HEMICELLULOSE COMPOUNDS ON CLAY MINERALS. Soil Sci. 84: 113-126. 1957.

The conversion of crop residues to organic matter by microorganisms is greatly influenced by the type of residue and by the kind of clay mineral present in a given soil. An isolation of some of these factors by the use of simple and relatively pure systems has been attempted with clay minerals and organic materials. Cellulose compounds of varying viscosity, pectins and hemicellulose compounds were adsorbed on clay minerals. The higher molecular weight cellulose compounds--methylcellulose and hydroxyethylcellulose--were adsorbed in smaller amounts than those of lower molecular weight. The results obtained with the methoxy pectins and the fluoride extractions indicates that pectins are

held on the anion exchange sites of clays or through a calcium linkage in much the same manner as that postulated for phosphorus. Proteinaceous compounds were found to be adsorbed more readily and in greater amounts by clay minerals than carbohydrate materials from a protein-carbohydrate mixture.

U. Del., Newark, Del.

Tamura, T. IDENTIFICATION OF CLAY MINERALS FROM ACID SOILS. J. Soil Sci. 9: 141-147. 1958.

A technique is described for the identification of clay minerals, the layers of which are difficult to expand or collapse by the usual treatment with glycerol and KCl. Samples are extracted for 3 to 6 hours in normal sodium citrate at pH 7:3 and 100° C. The citrate is renewed hourly. After the citrate extraction the interlayer spaces of some minerals can be expanded with glycerol and CaCl<sub>2</sub>.

Basal spacings of minerals previously identified as 'dioctahedral vermiculite' expand to 16 to 18 Å. After this treatment; hence, their identity is questioned.

The widespread occurrence in the north-eastern United States of clay minerals with 14-Å spacing necessitates this extraction for correct identification.

Conn. Agr. Expt. Sta., New Haven, Conn.

McLaren, A. D., Peterson, G. H., and Barhad, I. THE ADSORPTION AND REACTIONS OF ENZYMES AND PROTEINS ON CLAY MINERALS: IV. KAOLINITE AND MONTMORILLONITE. Soil Sci. Soc. Amer. Proc. 22: 239-244. 1958.

With kaolinite and montmorillonite the initial sorption of proteins is rapid; about three-fourths of the maximum uptake occurs in the first few minutes in suspension. Equilibrium is only reached in a matter of hours. Sorption isotherms are characterized by a rapid initial rise at low equilibrium protein concentrations followed by saturation of equilibrium values of about 0.5 mg. per ml. Sorption of proteins by the clays is low above the isoelectric points of the proteins.

The sorption of lysozyme by sodium montmorillonite in suspension results in the release of essentially all the bound sodium into the aqueous phase. The interlayer crystal lattice expansion of montmorillonite-protein complexes corresponds to a monolayer of adsorbed protein in some cases. Montmorillonite was used as a "caliper" to show that sorbed molecules of heat-denatured and native lysozyme are of the same thickness.

The maximum adsorption of lysozyme by kaolinite is closely related to surface area and only incidentally related to surface charge of kaolinite.

d(001) spacings are not proportional to the amount of alanine sorbed on montmorillonite. Adsorption as a function of pH reveals abrupt changes near the pH regions corresponding to ionization of the amino and carboxyl groups.

U. Calif., Berkeley, Calif.

Robinson, J. B. D. SOME CHEMICAL CHARACTERISTICS OF 'TERMITE SOILS' IN KENYA COFFEE FIELDS. J. Soil Sci. 9: 58-65. 1958.

Chemical data are presented for a number of related topsoil, subsoil, and termite-soil samples collected in mulched coffee established on a laterized red loam coffee soil.

In this study, 'termite soil' refers specifically to covered 'runs' of soil constructed by the termite on the outside of Napier grass mulches laid in mature coffee (Coffea arabica).

The comparisons of mean values for soil organic carbon, total base-exchange capacity, total exchangeable bases, exchangeable calcium, and exchangeable magnesium show that there is no statistically significant mean difference between the topsoil and termite-soil sample results. The subsoil sample results, however, are significantly lower than either the topsoil or termite-soil samples in all these results.

Similar comparisons of the mean values for soil pH and exchangeable calcium plus magnesium, when expressed as a percentage of the total exchangeable bases, show that

the soil has been altered by Odontotermes badius (Hav.) in constructing the 'runs'; it is left with a higher pH value and with an increased proportion of the total exchangeable bases present as calcium plus magnesium.

It is not possible from these results to say conclusively whether the termite-soil samples are derived from the adjacent topsoil or subsoil.

It is concluded that the presence of the termite soil which eventually becomes intimately mixed with the topsoil during cultivation and weed-control operations is not a point to be considered against Odontotermes badius (Hav.) when assessing the 'pros and cons' of its presence in mulched coffee.

Dept. of Agr. (Coffee Services), Ruiru, Kenya.

Tiller, K. G. THE GEOCHEMISTRY OF BASALTIC MATERIALS AND ASSOCIATED SOILS OF SOUTH-EASTERN SOUTH AUSTRALIA. J. Soil Sci. 9: 225-241. 1958.

Four profiles in the Mt. Burr forest area of south-eastern South Australia have been examined in detail. Two profiles were podzolized deep aeolian sands overlying buried soils which had developed on basaltic tuff, a third profile was developed on olivine basalt while the fourth was a composite profile developed on basaltic tuff and containing a buried profile formed on an earlier ash shower.

The main factors operative in influencing the geochemical distribution of the elements in these profiles were the translocation of elements by plant growth and their relative mobility on weathering, association with the clay fraction, and restricted drainage. In the aeolian sands Ca, Mn, and V with lesser amounts of K, P, Mo, Cu, Mg, Zr, and Al, were the elements which generally accumulated in the surface horizon as the result of plant action. In the surface soils of volcanic origin Ca, Mn, P, and Mg with lesser amounts of Cu and K accumulated. The highest concentrations in the clay fraction were, in general, for the aeolian sands Al, Fe, Ga, V, and Ni, and in the basaltic soils, Na, Al, Ga with, to a lesser extent, K, V, P, and Ni. In the soils developed on basaltic material the elements most readily lost from the weathering zones during soil formation were in decreasing order of magnitude, Ca, P > Na, Mg, Co, Zn > Cu, Mn > Ni. K, V, Ga, Mo, Fe, Al, Ti, and Zr were in general much less mobile and tended to remain incorporated in the weathering products and concentrated in the upper weathering zones. P, Zn, and Cu and to a lesser extent Mn, Fe, Ni, Co, and Ca were found to be more readily lost on weathering under conditions of restricted drainage.

The elements most concentrated in the hardpan of a ground-water podzol were, in decreasing order of magnitude, Fe > Al >> V, Zn, Ni > P, K, Mo > Na, Mn, Cu, and Ti. When the more strongly cemented nodules were separated for analysis it was found that relative to the matrix Fe > Al, V, and P, in that order, were most concentrated. Zn alone was lower in the nodules than the sandy matrix. Mn and Mo were most concentrated in the upper part of the hardpan, and Zn, V, Ni, Cu, Ti, and P in the lower part.

Some of the mineralogical changes which have taken place during the weathering of the basaltic material have been studied by examination of sand and clay fractions of the soil and thin rock sections. In the olivine basalt, the plagioclase and, to a lesser extent, olivine have weathered most readily. The main weathering products of the soil developed on the olivine basalt were kaolin and hematite. In the tuff the first important weathering product was montmorillonite, formed by the breakdown of the volcanic glass. This montmorillonite was found to break down in the upper weathering zones of the soils formed on tuff to give kaolin and goethite.

Div. Soils, Commonwealth Sci. and Indus. Res. Organ., Adelaide, S. Austral.

Schollenberger, C. J., and Whittaker, C. W. IMPROVED DETERMINATION OF CARBONATES IN SOIL. Soil Sci. 85: 10-13. 1958.

An apparatus and method for the determination of soil carbonate is described. The principal features are: recirculation within a closed system of the gas in the apparatus to insure complete absorption of carbon dioxide by barium hydroxide; immediate titration of excess barium hydroxide without exposure to the atmosphere; constant shaking of absorption as well as reaction flasks; and the thermostating of the latter to insure constant blanks. Accuracy and precision of the method are high.

J. Paper 35-57, Ohio Agr. Expt. Sta., Columbus, Ohio.



Freney, J. R. DETERMINATION OF WATER-SOLUBLE SULFATE IN SOILS. Soil Sci. 86: 241-244. 1958.

To obtain a measure of the true water-soluble sulfate content of a soil using the reduction method of Johnson and Nishita, it is necessary to prepare an extract free from colloidal material. Other inorganic sulfur compounds which would be estimated as sulfate must be removed from the solution. This can be achieved by precipitating the sulfate as barium sulfate and removing all soluble compounds by use of the Pregl filter stick. Results show that the extract should be made on a sample taken without delay directly from the field.

Div. Plant Industry, Reg. Pastoral Lab., Armidale, New South Wales, Austral.

Pratt, P. F., and Bradford, G. R. SEPARATION AND DETERMINATION OF TOTAL COPPER AND ZINC IN SOILS. Soil Sci. Soc. Amer. Proc. 22: 399-402. 1958.

Procedures for the anion-exchange separation of Cu and Zn from each other and from other elements, including Fe, are described. An aliquot of soil extract containing Fe in the ferric form and sufficient HCl to make 3M HCl is added to the resin columns, and the columns are washed with 3M HCl to remove ions that do not form or that form weak negative chloride complexes in HCl. The Cu is then eluted with 3M HCl. Ferric-Fe, which moves slowly in the 3M HCl, is eluted with 1M HCl, after which the Zn is eluted with 0.001M HCl. The Cu and Zn are determined colorimetrically by the use of zincon (2-carboxy-2'-hydroxy-5'-sulfoformazylbenzene).

The separation and determination of Cu and Zn by these procedures give values in good agreement with dithizone extractions and determinations. The advantages of the new procedures are their simplicity and rapidity. Digestion with HClO<sub>4</sub> does not completely dissolve Zn for soil samples.

U. Calif. Citrus Expt. Sta., Riverside, Calif.

Matelski, R. P., and Yien, C. H. A RAPID FIELD AND LABORATORY PROCEDURE FOR DETERMINING THE SODIUM CONTENT OF THE SOIL. Soil Sci. Soc. Amer. Proc. 22: 500-502. 1958.

Rapid, field or laboratory, semiquantitative fluorometric methods for determining the exchangeable and soluble sodium contents in soils have been developed. Determinations on alkali soils can be completed in 15 minutes or less. The basis for the methods is the development of a green-yellow fluorescence upon addition of a uranyl zinc acetate solution to the soil or the water extract of the soil. The rate and intensity of fluorescence is measured using commercially available portable fluorescent equipment. Fluctuations in organic matter content, salt content, pH, and texture on the sodium content were without apparent effect. Potassium and phosphorus also do not interfere with the fluorescent determination of sodium.

Numerous soils ranging in exchangeable and soluble sodium contents from 0.1 to 18.1 and from 0.1 to 9.7 me. per 100 g. soil, respectively, were examined. These soils represented side ranges of physical and chemical properties.

Neb. Agr. Expt. Sta., Lincoln, Nebr.

Ulrich, A., Ririe, D., Hills, F. J., George, A. G., and Morse, M. D. I. PLANT ANALYSIS: A GUIDE FOR SUGAR BEET FERTILIZATION. Johnson, C. M. and Ulrich, A. II. ANALYTICAL METHODS: FOR USE IN PLANT ANALYSIS. Calif. Agr. Expt. Sta. B. 766, 77 pp. 1959.

As successive cropping decreases the native fertility of California soils, fertilization becomes increasingly important. Efficient fertilization is possible if

1. the nutrients in short supply have been determined, and
2. these nutrients are applied in the proper amounts and at the right time and place to assure effective utilization by plants.

These requirements for efficient fertilization are difficult to determine. We are constantly looking for scientific tools to guide fertilization practices.

This bulletin, in its first part describes one of the newer tools of modern agriculture, plant analysis, and tells how to use it to determine the fertilization needs of sugar beets under commercial field conditions.

The second part of the bulletin describes the analytical methods of plant analysis for many crops as they are used in University of California laboratories.

Calif. Agr. Expt. Sta., Berkeley, Calif.

## Soil Physics

Larson, W. E., Burrows, W. C., and Hazen, T. E. EQUIPMENT AND METHODS FOR MEASUREMENT OF SOIL TEMPERATURE. U.S.D.A., A.R.S. 41-27, 32 pp. 1959.

Crop production research workers are increasingly recognizing the need for more information on soil temperature. Management practices for tillage, drainage, and residue can influence soil temperature materially and hence by this means as well as others have an influence on crop growth. The increased use of agricultural chemicals such as anhydrous and liquid ammonia fertilizers, herbicides, and soil insecticides has made necessary a better knowledge of soil temperature and the factors affecting it.

A number of types of soil temperature measuring devices are being used for routine determinations. Three types of instruments have been used extensively in soil-tillage studies in Iowa. The three types are mercury-in-glass thermometers, bimetal dial thermometers, and multiple-point recording potentiometers using copper-constantan thermocouples in combination with a switching device capable of recording up to 320 separate temperatures in 1 cycle.

It is the purpose of Part I of this report: (a) To present information on the accuracy and suitability of mercury-in-glass thermometers, bimetal dial thermometers, and thermocouples together with the multiple-point recorder, for routine field determinations of soil temperature; (b) To show the relationship of daily maximum and minimum soil temperatures at various depths to soil temperatures at certain times of the day. The advantages, limitations, and points to consider for each of the instruments are given. Part II describes the construction of the switching mechanism that is used with the multiple-point recorder and the approximate cost.

ARS, USDA, Inform. Div., Washington 25, D. C.

## Soil Biology

Broadbent, F. E., Hill, G. N., and Tyler, K. B. TRANSFORMATIONS AND MOVEMENT OF UREA IN SOILS. Soil Sci. Amer. Proc. 22: 303-307. 1958.

Samples of several California soils were incubated in a controlled environment chamber after addition of varying amounts of urea in solution. Samples were analyzed after time ranging from 1 day to 8 weeks. In short-term experiments analyses for residual urea were performed at frequent, short intervals, and in longer-term experiments nitrification of the hydrolysis product was followed. At 45°F., 200- and 400 ppm. amounts of urea were completely hydrolyzed after 7 days, although some urea remained after 3 days. At 75°F., no urea remained after 2 days when the initial application was 400 ppm. or less. At 800 ppm., considerable urea remained at 3 days but none at 14 days.

Urea was rapidly nitrified in all soils at moderate levels of application but was inhibited in the poorly buffered Hanford sandy loam by the 800-ppm. application due to the high pH produced.

Leaching experiments with soil columns showed that urea moves less rapidly than nitrate, partly because of rapid hydrolysis to ammonia and partly because urea itself is held by weak absorption forces.

U. Calif., Davis, Calif.



Fisher, W. G., Jr., and Parks, W. L. INFLUENCE OF SOIL TEMPERATURE ON UREA HYDROLYSIS AND SUBSEQUENT NITRIFICATION. Soil Sci. Soc. Amer. Proc. 22: 247-248. 1958.

Nitrogen as urea was added to soil samples of surface horizon of Hermitage silt loam that was low in ammonia and nitrate nitrogen at rates equivalent to 100 to 200 pounds of N per acre. These samples were placed in temperature-controlled chambers maintained at 10°, 20°, and 30° C. The soil moisture was maintained near field capacity and duplicate samples were analyzed at the end of 1, 2, 3, and 5 weeks for ammonia and nitrate nitrogen.

The results show that there was generally an increase in the rate of urea hydrolysis and subsequent nitrification with increase in soil temperature. The higher rate of urea application increased the average amount of hydrolysis and nitrification at all temperatures except 10° C. The 10° C. temperature had very nearly a constant rate of nitrification, about 25 pounds of N per acre per week, at both rates of urea application. The initial soil pH was 6.8 and there was no great change in the soil pH during this study.

U. Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Soulides, D. A., and Clark, F. E. NITRIFICATION IN GRASSLAND SOILS. Soil Sci. Soc. Amer. Proc. 22: 308-311. 1958.

Nitrification studies were made on seven paired soil samples representing closely adjacent grassland and intertilled sites in the following soils: Codorus sil, Bladen cl, Cecil sl, Hixton fsl, Fayette sil, Honeoye sil and Pachappa sl. All samples were incubated unamended and with 0.1% urea for periods of 2, 4, 6, and 9 weeks. Determinations were made for ammonia, nitrite, and nitrate nitrogen, and for urea nitrogen when indicated.

Grassland samples of the Codorus and Bladen soils, pH 4.7 and 4.9, respectively, showed accumulations of ammonia when incubated unamended. Such accumulations were not apparent in the five remaining grassland samples ranging in pH from 5.7 to 7.9. All grassland samples, irrespective of pH, when amended with 0.1% urea showed higher retention of ammonia and lesser nitrate production than did their intertilled counterparts. Urea-amended soils initially alkaline or becoming alkaline following addition of urea showed nitrite accumulation, irrespective of whether the samples came from grassland or intertilled sites. Soils showing nitrite accumulation showed greater nitrogen deficits than did the remaining soils. Greater nitrogen deficits were commonly encountered in the grassland than in the intertilled members of paired, urea-treated samples. There appeared a direct relationship between nitrite accumulation and magnitude of nitrogen deficit.

SWCRD, ARS, USDA, Beltsville, Md.

McIntosh, T. H., and Frederick, L. R. DISTRIBUTION AND NITRIFICATION OF ANHYDROUS AMMONIA IN A NICOLLET SANDY CLAY LOAM. Soil Sci. Soc. Amer. Proc. 22: 402-405. 1958.

A roughly cylindrical distribution of  $\text{NH}_3$  centered at the knife openings was found when anhydrous ammonia was applied with a field applicator at a depth of 4 inches, by sampling an 8- by 8- by 2-inch cross section perpendicular to the applicator row.  $\text{NH}_4\text{-N}$ ,  $\text{NO}_3\text{-N}$  and pH were determined on each 1-inch square subsample.  $\text{NH}_4\text{-N}$  decreased from a maximum concentration of 1,300 to 2,000 ppm. (pH 9.5) at the center to less than 200 ppm. (pH 8) in the area about 1 1/2 inches away from the center of the retention zone. After 2 weeks, the maximum concentration of  $\text{NH}_4\text{-N}$  was about 800 ppm. (pH 8.8) in the center decreasing to less than 100 ppm. (pH 7.0) in the area about 2 1/2 inches away from the center of the retention zone.

Nitrification initially proceeded more rapidly in the outside 2 inches of the retention zone where the concentration of  $\text{NH}_4\text{-N}$  was less than 400 ppm. Later in the original ammonia retention zone, nitrification appeared to be limited by low pH and nitrate concentration; at the end of 4 weeks the pH had decreased to a value of 5.0 to 5.5 and  $\text{NO}_3\text{-N}$  had

increased until 200 to 300 ppm. were present. Ammonia applied in November just prior to freezing showed little nitrification by March. Rapid nitrification began in mid-April when soil temperatures rose above 40° F. Approximately 8 weeks were required to completely nitrify the ammonia.

Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Stevenson, F. J., and Dhariwal, A. P. S. DISTRIBUTION OF FIXED AMMONIUM IN SOILS. Soil Sci. Soc. Amer. Proc. 23: 121-125. 1959.

Fixed ammonium was determined in 17 profiles representative of most of the great soil groups occurring within the North Central Region of the United States. The results showed that a vast reservoir of N exists in the terrestrial areas of the world as ammonium held within the lattice structure of clay minerals, thereby revealing a heretofore missing link in the N cycle.

The amount of fixed ammonium in the soil was found to depend upon the type and amount of clay minerals present. With respect to clay mineral type, the order was illite montmorillonite kaolinite. Drainage, type of vegetative cover, and extent of leaching of the profile by percolating water had little effect on the fixed ammonium content of the soil. Cropping decreased the amount of fixed ammonium in surface soil; however, the fraction of the N present as fixed ammonium was greater for cropped soil than for uncropped soil.

Ill. Agr. Expt. Sta., Urbana, Ill.

Alexander, M., and Stojanovic, B. J. EFFECT OF INORGANIC NITROGEN ON NITRIFICATION. Soil Sci. 86: 208-215. 1958.

A study has been made with the soil perfusion technique of the nitrification patterns in Honeoye silt loam, pH 7.70, treated with various concentrations of ammonium or nitrite nitrogen and maintained at constant reaction. It has been shown that the addition of ammonium-nitrogen in quantities of 250 µg. N/ml. perfusate or greater leads to a depression in the rate of nitrate formation. Analysis of the kinetics of the oxidation shows that there is no effect of  $\text{NH}_4\text{-N}$  concentration on the rate of ammonium oxidation. However, there does occur an accumulation of nitrite which, at constant soil reaction, is proportional to the amount of ammonium sulfate initially added. Nitrites apparently accumulated only when there was some  $\text{NH}_4\text{-N}$  remaining in the metabolite solution, but then rapidly disappeared once the  $\text{NH}_4\text{-N}$  had been oxidized.

Nitrite levels greater than any observed during ammonium oxidation did not prevent the transformation of nitrite to nitrate. Hence it is concluded that ammonium-nitrogen applied in high concentrations can cause the accumulation of nitrites in soils of high pH by virtue of the specific effects of the original substrate on the Nitrobacter-catalyzed oxidation of nitrite. These results are in agreement with cultural studies of the responsible microorganisms. Previous reports of the occurrence of nitrites in laboratory field trials are reviewed, and it is suggested that the build-up and persistence of this substance is favored by alkaline reaction and high levels of applied ammonium or ammonium-forming fertilizers possibly by means of an inhibition of Nitrobacter by free ammonia.

Agron. Paper. 436, N. Y. State Col. Agr., Ithaca, N. Y.

Anderson, G. R. ECOLOGY OF AZOTOBACTER IN SOILS OF THE PALOUSE REGION: I. OCCURRENCE. Soil Sci. 86: 57-62. 1958.

Field surveys, extending over a period of three growing seasons, revealed that 47 percent of 189 arable soils tested contained Azotobacter. The percentage of Azotobacter-positive soils varied considerably at times. This variance was related not only to the total yearly rainfall but to the amount of summer precipitation. The only soils showing populations of  $10^3$  or more were soils which remained moist during most of the year.

Physical and chemical studies of the Palouse soils, with the exception of moisture retention and pH, revealed no essential difference between soils with large populations of Azotobacter and those without.

Tests for factors in Palouse soils toxic for *Azotobacter* were completely negative. In fact, concentrated soil extracts were advantageous to *Azotobacter* growth.

U. Idaho, Moscow, Idaho.

Sen, A., and Iswaran, V. VARIATION OF CHARACTERISTICS AND NITROGEN-FIXING CAPACITIES OF *AZOTOBACTER* IN SOME INDIAN SOILS. *Soil Sci.* 87: 46-49. 1959.

*Azotobacter* populations of some soils from different parts of India were studied, and characteristics of some forty strains of the organism isolated from the soils were determined. The isolations were based on appearance of distinctly different types of colonies on a single dilution plate of mannite agar from each soil. No attempt was made to differentiate the strains into different species.

From the large variations in the dimensions of different cells of a single strain, size of strain could not be used as a basis of differentiation. Strains could be differentiated, however, on the basis of ability to utilize peptone, benzoate, dextrin, and starch and on their acid, alkali, and salt tolerance.

Differences between characteristics of strains showed also in their nitrogen-fixing capacities. In soils from Cheshmashali, Kashmere, Sadul Sahr, and Rajasthan, the differences between nitrogen-fixing capacities of the various strains were not significant; they were significant in the case of soils from Banihal, Khilan Marg, Delhi, and Raipur.

Deviations of the nitrogen-fixing capacities of individual strains from the mean values of the nitrogen-fixing capacities of different strains in a single soil were not very large except in Khilan Marg soil and, to a certain extent, in Delhi soil.

Indian Agr. Res. Inst., New Delhi, India.

McCalla, T. M. MICROORGANISMS AND THEIR ACTIVITY WITH CROP RESIDUES. *Nebr. Agr. Expt. Sta. S. B.* 453, 31 pp. 1959.

Studies were started in 1941 on some of the soil microbiological problems involved in stubble mulching. Studies have been made of the rate of decomposition of different types and amounts of residues under both laboratory and field conditions. Microorganisms were found to affect soil structure stability and water intake.

A study of the types, number and position of microbial population with stubble mulching shows a greater number of the aerobic types of microorganisms and nematodes developing in the surface inch of soil. The number of denitrifying organisms was slightly higher with stubble mulching.

Because of the lower temperatures and higher moisture content, the number of earthworms was significantly higher with stubble mulching than in plowed land. Available nitrogen in the field was 5 to 10 percent less with stubble mulching than with plowing. Nitrate-nitrogen was low in stubble mulching and equal to that obtained on plowed land.

Ammonia losses during decomposition on the surface of the soil were insignificant with residues such as wheat straw. Amounts of less than 5 pounds per acre were lost with sweetclover. Phosphorus, organic matter, nitrogen, and pH tend to be higher on the stubble mulching than land that is plowed.

Many of the cropping and tillage practices that a farmer uses are effective in crop production because of their influence on microbial activity. For example, when the soil is tilled aeration may be improved, and aeration is favorable for the growth of the nitrogen, sulfur and iron oxidizing organisms. When the soil environment lacks oxygen, it is unfavorable as an environment for many plants. Legumes are inoculated, planted, and turned back into the soil to increase available nitrogen for the following crop.

Every practice or management system influences microbial activity which, in turn, influences the decomposition of plant residues, the availability of nutrients, and the soil structure. These all influence crop growth and the growth of the crops determines the soil cover and the erosion protection afforded. 47 references cited.

SWCRD, ARS, USDA, and U. Nebr. Expt. Sta., Lincoln, Nebr.



The total phosphorus content of soils ranges approximately from 0.025 to 0.3% of  $P_2O_5$ . In a hectare this amounts to about 253 to 3036 pounds of  $P_2O_5$  per acre (102 to 1229 lbs per acre), only a part of which is available to plants. Soil phosphorus is represented chiefly in the form of various basic phosphates of calcium, iron, aluminum, and so forth. A significant part of the soil phosphorus (up to 50%) can be combined with organic matter in the form of nucleoproteins, lecithin, phytins, sugar and alcohol phosphates, humic-phosphates, and so forth. Most of these organic compounds of phosphorus are slightly available or are completely unavailable to plants and are assimilated only after they have been decomposed or mineralized. In studying the soil productivity we must ascertain the amount in them both of the phosphates which are more soluble and easily available to plants and also of the common phosphorus compounds which are slightly soluble and barely available.

In large-scale practice we must consider the possibility of an inadequate amount of phosphorus which is available to plants. This inadequacy is related to a lack of phosphates in parent material as well as to a soil depletion by preceding crops. A certain amount of phosphorus does return to the soil with manure, which contains 0.2 to 0.3%  $P_2O_5$ . Phosphorus found in grain, milk, meat, wool, and so forth but not in manure, may be supplied by supplementary application of synthetic mineral phosphorus fertilizers.

A primary feature of superphosphate--a universal phosphorus fertilizer--is the rapid transfer into the soil of phosphorus in its less soluble form. Therefore, replacing manufactured superphosphate by a cheaper form of phosphorus fertilizer--ground rock phosphate--is entirely justified.

The author makes the following conclusions:

1. A summary of agrochemical investigations for the last half century has shown that the basic factors in the effectiveness of rock phosphate and other slightly soluble calcium phosphates are the acidity of soils, the specific characteristics of plants (acidity of their root secretions), certain agricultural practices, and so forth.
2. The data from the literature concerning the significance of microorganisms in increasing the availability to plants of barely soluble and little available basic calcium phosphates show the following:
  - a) In a series of experiments microorganisms (different species of bacteria and particularly of fungi) acidified the reaction of the medium (nutrient solution or soil), which should have increased the solubility and availability to plants of the more basic calcium phosphates.
  - b) Microorganisms (bacteria and especially fungi) were able to assimilate the nonbasic calcium phosphates and at the same time partially to dissolve phosphorus during the metabolic process connected with the secretion of different organic acids into the medium.
  - c) The relative importance of the work of microorganisms in general and of their individual species among the other factors increasing the availability to plants of insoluble calcium phosphates (acidity of the medium, solubilizing action of the root systems of plants) has not been developed sufficiently in the literature. It requires further study, as does the question (of importance in production) of the need to add specific microorganisms under certain soil conditions (to peat-podzolic soils) to increase the utilization by plants of the more basic calcium phosphates.

#### 30 References Cited.

Amer. Inst. of Biol. Sci., 2000 P. St., N. W., Washington 6, D. C.

Casida, L. E., Jr. PHOSPHATASE ACTIVITY OF SOME COMMON SOIL FUNGI. Soil Sci. 87: 305-310. 1959.

Several representative species of soil fungi have been studied for their content of phosphatase enzymes. The results indicate that some members of the genus *Aspergillus* contain especially active acid phosphatases for phosphorus-containing compounds similar

to those found in the soil. In particular, it has been shown that these fungi contain an active acid phytase which is able to partially dephosphorylate ferric phytate, a compound previously considered almost inert in the soil.

Pa. Agr. Expt. Sta., University Park, Pa.

Hofer, A. W. SELECTIVE ACTION OF FUNGICIDES ON RHIZOBIUM. Soil Sci. 86: 282-286. 1958.

Studies were made of the effects of three fungicides commonly used for seed treatment upon inoculants for alfalfa, birdsfoot trefoil, and clover. The Szybalski gradient plate method, the agar block method of Allyn and Baldwin, and a greenhouse method were applicable to the problem and gave comparable results. By each of these methods it was found that the fungicides varied in their toxic action toward the three groups of legume bacteria from complete toxicity to little or no action. The bacteria for alfalfa were least injured by the fungicides while those for birdsfoot trefoil were intermediate and those for clover were most sensitive. In view of these variations, it would be advisable to submit fungicides proposed for use on legume seeds to quantitative tests of their interaction with inoculants.

N. Y. State Agr. Expt. Sta., Ithaca, N. Y.

Martin, J. P., Harding, R. B., Cannell, G. H., and Anderson, L. D. INFLUENCE OF FIVE ANNUAL FIELD APPLICATIONS OF ORGANIC INSECTICIDES ON SOIL BIOLOGICAL AND PHYSICAL PROPERTIES. Soil Sci. 87: 334-338. 1959.

A study was made of the influence of 5 annual applications of 8 organic insecticides to 2 field soils (Ramona sl and Holtville scl) on soil biological and physical properties. The chemicals included Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Lindane, and Toxaphene. Dosage rates were chosen to approximate the maximum use in field practice. The insecticides exerted no measurable effect on numbers of soil bacteria and fungi, on kinds of soil fungi developing on dilution plates, on the ability of the soil population to perform the normal functions of organic matter decomposition and ammonia oxidation, on water infiltration, or on soil aggregation.

U. Calif. Citrus Expt. Sta., Riverside, Calif.

Estermann, E. F., and McLaren, A. D. STIMULATION OF BACTERIAL PROTEOLYSIS BY ADSORBENTS. J. Soil Sci. 10: 64-78. 1959.

A comparison of the initial rate of  $\text{NH}_3$  production from protein adsorbed on kaolinite and non-adsorbed protein by bacteria showed that adsorption enhanced the rate. This effect occurs with both adsorbed and non-adsorbed organisms, and disappears when a non-adsorbed substrate (denatured lysozyme predigested by chymotrypsin) is used. With *Flavobacterium* sp. the effect occurred with a dilute inoculum and disappeared with a concentrated one. Shaking cultures of *Flavobacterium* sp., which ordinarily is c. 98 percent adsorbed to kaolinite, and of *Pseudomonas* sp., which is only c. 30 percent adsorbed to kaolinite statically, which might dislodge organisms from the clay, did not decrease rates of  $\text{NH}_3$  liberation. It is concluded that the kaolinite acts as a concentrating surface for adsorbed substrate and exoenzymes, and thereby brings about a more rapid breakdown of substrate. *Flavobacterium* sp. readily attacks protein adsorbed on bentonite with a resulting decrease in (001) X-ray diffraction spacing.

U. Calif., Berkeley, Calif.

Menzies, J. D. OCCURRENCE AND TRANSFER OF A BIOLOGICAL FACTOR IN SOIL THAT SUPPRESSES POTATO SCAB. Phytopathology 49: 648-652. 1959.

Potato scab is common and often serious in the newly irrigated areas of central Washington, but rare in fields that have been farmed under irrigation for many years. Pot experiments showed that these older farmed soils exert a persistent suppressing effect on scab following inoculation with the pathogen. When heavily infested soil was

mixed with equal amounts of suppressing soil, scab was controlled. This effect was lost if the suppressing soil was first steamed. Control of scab in infested soil was good from a combination amendment of 1% suppressing soil and 1% alfalfa meal. Neither constituent was consistently effective alone. A biological factor, possibly microbial, appears to have developed naturally in these older farmed soils, and can be established in other soils by mass soil inoculation fortified with a microbial food source.

These potatoes were raised on soil with a pH of 6.2 to 7.5.

SWCRD, ARS, USDA, Prosser, Wash.

## EROSION CONTROL

### Erosion Equation

Turelle, J. W. RE: FIELD ESTIMATIONS OF WIND ERODIBILITY BASED UPON EXISTING SOIL SURFACE CONDITIONS (CLODDINESS, RESIDUE, AND ROUGHNESS) AND WIDTH OF FIELD. U.S.D.A., S.C.S. Tech. Note 7. 1959.

The primary purpose of this technical note is to illustrate how Work Unit personnel in the presence of land operators may estimate wind erodibility of a field. There are a number of other uses which may be made of this procedure, such as evaluation of cropping systems, checking erodibility of specific soil types, etc. These estimations are especially useful when there are wide strips or fields with insufficient residue and surface roughness to protect the soil from wind erosion.

The determination of wind erodibility estimates will help to point out to land operators: Quantity of soil losses that may occur under average wind velocities and unfavorable existing surface conditions; need for sufficient residue and its relative effect on reducing wind erosion; need for establishing and maintaining adequate strip widths to supplement the residue; and need for surface roughness.

SCS, USDA, Lincoln, Nebr.

Bertoni, J., Larson, W. E., and Shrader, W. D. SOIL AND WATER MANAGEMENT AND CONSERVATION. Soil Sci. Soc. Amer. Proc. 22: 571-574. 1958.

Using rainfall intensity and runoff rate measurements for plots with slope lengths of 36.3, 72.6 and 145.2 feet, infiltration rates were determined by the graphical method of Sharp and Holtan for 10 storms occurring during the years 1938 to 1942, inclusive. The plots on Marshall silt loam had been cropped to continuous corn since 1932. The average initial infiltration rate for all storms and all slope lengths was 0.79 inch per hour and the final infiltration rate was 0.21 inch per hour. The final infiltration rate varied with storms and slope lengths from 0.60 to 0.10 inch per hour. The average infiltration rate curve calculated from the mean of all curves for all storms and all slope lengths was expressed by the equation  $f = 0.211 + 1.019 e^{-0.056t}$ . Final infiltration rate appears to increase up to June and July and then decrease rather sharply during August and September.

J. Pa. J-3371, Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Wischmeier, W. H., and Smith, D. D. RAINFALL ENERGY AND ITS RELATIONSHIP TO SOIL LOSS. Amer. Geophysical Union Trans. 39: 285-291. 1958.

A relatively simple procedure is presented for computation of kinetic energy of a rainstorm for information on a recording-raingage chart. An equation is developed describing rainfall energy as a function of rainfall intensity. The effects of rainfall energy and its interaction with other variables are evaluated in multiple regression analyses based on data representing four soil types. Application of this information to separate the effects of rainfall from those of physical and management characteristics in plot data is discussed briefly.

SWCRD, ARS, USDA and Purdue Agr. Expt. Sta., Lafayette, Ind.



McIntyre, D. S. PERMEABILITY MEASUREMENTS OF SOIL CRUSTS FORMED BY RAINDROP IMPACT. Soil Sci. 85: 185-189. 1958.

A method was developed for the measurement of permeability of surface crusts, and permeability values were measured for two cultivated soils and a virgin soil, all of the one-soil type. Crusts were formed over small areas by simulated rainfall under two different conditions: soil splash lost from the surface, and 70-80 percent soil splash retained by the use of baffles. Thin sections were made from crusts formed on one of the cultivated soils and the make-up of the crust determined microscopically. In the two cases the crust consisted of a thin compact skin seal 0.1 mm. thick over the surface and a washed-in layer where porosity had been reduced considerably.

Permeabilities were  $5 \times 10^{-7}$  cm./sec. and  $5 \times 10^{-6}$  cm./sec. The washed-in layer was thicker when splash was retained (2.5 mm.) than when splash was lost from the surface (1.5 mm.) The underlying soil had a permeability of about  $10^{-3}$  cm./sec.

Commonwealth Sci. and Indus. Res. Organ., Adelaide, S. Austral.

McIntyre, D. S. SOIL SPLASH AND THE FORMATION OF SURFACE CRUSTS BY RAINDROP IMPACT. Soil Sci. 85: 261-266. 1958.

The mechanics of the splash process and the formation of surface crusts were investigated using small-area containers and simulated rain. A few field measurements were also made on soil splash. It was found that soil splashed from a small area is greater for soils of higher stability, and that decline in splash rate is due to crusting or sealing of the surface. The formation of surface crusts was found to be due mainly to washing-in of fine particles and compaction of the immediate surface (0.1 mm.) by raindrop impact. Frequent changes in splash rate are attributed to removal of the skin seal by turbulence in the water above it followed by its formation once more; permeability values are presented as evidence of this.

Commonwealth Sci. and Indus. Res. Organ., Adelaide, S. Austral.

## Critical Areas

Hays, O. E., and Taylor, R. E. CONSERVATION METHODS FOR THE UPPER MISSISSIPPI VALLEY (FAYETTE SOIL AREA). U.S.D.A., Farm. B. 2116, 12 pp. illus. 1958.

The Fayette soil area is one of the most severely eroded farming areas in the North Central States. It comprises 12 million acres in southwestern Wisconsin, southeastern Minnesota, northeastern Iowa, and northwestern Illinois. It includes, Fayette, Dubuque, Clinton, and stony land, but is characteristically made up of grayish-brown, hilly silt loams.

Thousands of tons of good top soil are being washed away every year. Most sloping fields have eroded to the extent that subsoil is being turned by plowing.

Dairying is the chief agricultural enterprise in the Fayette soil area. Cropland is used mostly for growing corn, grain and hay--crops necessary to dairying. About half of the farmland is used for pasture, but of this amount, 39 percent is pastured woodland. It is estimated that about 80 percent of the woodland on farms is being pastured.

Effective control measures in this area are vitally important to halt the continued loss of productive fields.

This Farmers' Bulletin explains: The erosion damage; how crops affect erosion; how seasons affect erosion; and how to control erosion.

SCS, USDA, Inform. Div., Washington 25, D. C.

## SOIL MANAGEMENT

### Cropping Practices

Van Doren, C. A., and Hays, O. E. INTERSEEDING LEGUMES IN CORN. U. S. D. A., L. 435, 8 pp. 1958.

Interseeding legumes and grasses in wide-row corn is a promising new practice for farmers in the Corn Belt. The corn serves as a nurse crop for establishing green manure and meadow crops. Traditionally, cereal grains have served this purpose.

Success with this practice, however, can be assured only when there is adequate soil moisture. Using corn as the nurse crop offers more benefits than the conventional practice of seeding in grain. There is less erosion loss from the field and the two crops together give more feed value per acre.

For interseeded green manure crops, corn rows may be spaced 60 to 80 inches apart, or spaced alternately at 40 and 80 inches. A row spacing of 60 or 80 inches is recommended when interseeding for hay production.

Interseeding legumes in corn permits the use of a corn-hay rotation. At the La Crosse Soil and Water Conservation Station, Wisconsin, a rotation of corn-hay was much more effective in controlling erosion than a rotation of corn-grain-hay. In a corn-hay rotation, the land is open only from the time of plowing for corn until the seeding has become well established in the corn. The land is well protected during the late summer, winter and spring months.

Erosion control is even better when interseeding is combined with wheel-track planting of corn. This system protects the land with a meadow crop right up until corn planting time. The plowed land is in a rough, highly absorptive condition until the first cultivation of corn. Interseedings give the land a good protective cover after the first of August. This system protects the land with a dense cover except during June and July.

ARS, USDA, Inform. Div., Washington 25, D. C.

Cooke, G. W., Mattingly, G. E. G., and Williams, R. J. B. CHANGES IN THE SOIL OF A LONG-CONTINUED FIELD EXPERIMENT AT SAXMUNDHAM, SUFFOLK. J. Soil Sci. 9: 298-305. 1958.

A four-course rotation experiment was carried out on wheat, roots (field beets, turnips or swedes), barley, and legumes. Yields of all crops were much increased by phosphate fertilizers, nitrogen fertilizers increased yields of non-legumes, extra yields from potash fertilizers were smaller. Fifty-six years of continuous manuring caused the following changes in the calcareous boulder clay soil: Plots receiving farmyard manure contained half as much again organic carbon as plots receiving fertilizers, plots receiving N and P fertilizers contained slightly more organic matter than plots without these fertilizers. Total soil nitrogen was considerably increased by farmyard manure and was slightly higher on plots receiving sodium nitrate than on plots without nitrogen fertilizer. Total soil phosphorus was built up by farmyard manure and by bone meal, and to a smaller extent by light annual dressings of superphosphate. 'Soluble phosphorus' determined by three methods differentiated clearly between plots which had received phosphate fertilizers and those which had received none. An accumulation of bone meal residues was demonstrated by dilute hydrochloric-acid extraction, but not by methods involving extraction with 0.5 M sodium bicarbonate or equilibrium with 0.01 M calcium chloride. Soluble-phosphorus values by all three methods indicated the presence of fertilizer residues more clearly than did values for total soil phosphorus. The soil contained a large quantity of total potassium and the values were not materially affected by manuring. Dilute-HCl-soluble-K and exchangeable-K values differentiated between plots which had received potash fertilizers and those which had received none. They also reflected changes in soluble potassium caused by the different amounts of potassium removed in the crops grown.

Rothamsted Expt. Sta., Harpenden, England.



A series of experiments was conducted on Norfolk lfs over a 11-year period to determine (1) management practices which result in highest yields of certain cash crops (corn, peanuts and oats), and (2) effects of these practices on the soil.

The management practices studied were (1) crop rotation, (2) fertilizer level, (3) liming requirement and (4) green manure crops (lupines, soybeans, Crotalaria spectabilis, and in some cases oats).

## I. Superior Management Practices for Best Yields of Cash Crops

1. Peanuts should be grown in rotation for best yields. A 3-year rotation found satisfactory was: peanuts, lupine under the first year; corn, oats for grain the second year; and soybeans followed by oats the third year.
2. Corn yields do not decline as rapidly as peanuts when grown continuously.
3. Lupines do not grow well after peanuts.
4. When peanuts or soybeans are grown in a 3-year rotation such as that referred to in 1 above they make about the same yields if part of or all of the fertilizer is applied to the preceding crop than when fertilized directly.
5. Corn and oats grown in a 3-year rotation should be fertilized directly.
6. Corn, peanuts, soybeans, oats, and lupine need supplemental fertilizer. When grown in the 3-year rotation mentioned in 1 above, a good rate of fertilization for corn and oats is 600 pounds per acre of 4-12-12 at planting with 60 to 100 pounds per acre of nitrogen as a side-dressing and a top-dressing. The nitrogen may be reduced to half the rate where the crop follows a legume cover crop making good growth. Soybeans, Crotalaria, and lupine should receive 450 pounds per acre of 0-14-14 and peanuts 200 pounds per acre of 0-14-14.
7. When peanuts are hogged-off and followed by native cover, yields decline about the same as continuous peanuts harvested and followed by lupine plowed under for green manure.
8. Lime is required to produce good yields. After 11 years adequate lime increased peanut yields 250 to 580 pounds per acre, corn yields up to 26 bushels and soybean yields as much as 7 bushels.

## II. Effect of Cash Cropping and Management Practices on the Soil

1. Norfolk lfs had approximately 400 pounds per acre of exchangeable calcium in the virgin state. When cropped for 7 years to a 3-year rotation, the level was reduced to approximately 100 pounds per acre. At this point a ton of lime improved yields of peanuts, corn and soybeans, but did not raise the pH above 5.7. It would require approximately a ton of lime every 5 years to maintain the pH of soil cropped to a 3-year rotation with corn, peanuts, oats, and soybeans.
2. The soil organic matter and moisture equivalent decreased when a virgin soil was cropped, regardless of the soil management practices. The decrease was larger when continuous peanuts were grown and the vines and nuts removed than for continuous corn where only the ears of corn were harvested. The levels of exchangeable calcium, potassium, and magnesium were correlated with the organic matter. In sandy soils of this type where the clay content is low, organic matter is important, since it is the major source of the exchange capacity. The detrimental effect of peanuts on the level of soil organic matter as compared to corn is probably part of the reason why yields decrease more rapidly when peanuts are grown continuously than when corn is grown continuously. Organic matter in the high fertilized corn plots was higher than in the low fertilized plots.
3. Applied phosphorus remained in the surface 6" layer of soil. Calcium and potassium moved down the profile, but not below the root zone of most crops.

4. Magnesium moved down the profile to 30 inches and deeper and probably part of it leached out of the soil. This means that an old land which has never been limed before, dolomitic instead of calcic lime should be applied. After an application of dolomite, calcic lime may be used alternately.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Agronomy Department. RESEARCH IN CROPS AND SOILS-A PROGRESS REPORT.  
S. Dak. Agr. Expt. Sta. C. 136, 23 pp. 1957.

The Experiment Station Agronomy Farm, located 1 mile east of Brookings, is representative of a large area of land in eastern South Dakota. It consists of 160 acres which are laid out in various soil and crop experiments. The soil, commonly called "loam" and classified as Vienna loam, is in a good state of fertility.

Results of the experiments on this farm will indicate what may be expected from similar soil management, cropping systems, and crop varieties on the same type of soil and under comparable climatic conditions.

Numerous experiments are in progress on this farm. The information in this circular is a progress report on those experiments for which results can now be evaluated.

Agr. Expt. Sta., S. Dak. State Col., Brookings, S. Dak.

Fritschen, L. J., and Hobbs, J. A. EFFECT OF CROP ROTATION AND FERTILIZER TREATMENT ON THE NITROGEN AND ORGANIC CARBON CONTENTS OF A PRAIRIE SOIL. Soil Sci. Soc. Amer. Proc. 22: 439-441. 1958.

The effects of cropping systems and soil treatments on the nitrogen and organic carbon contents of Geary silt loam were studied in 1915, 1923, 1934, 1946, and in 1956 on the Agronomy Farm at Manhattan, Kansas.

Losses of nitrogen and organic carbon were largest where the original contents of these constituents were highest. Losses were most rapid in the earlier years of the study. Largest losses occurred under a 3-year rotation of corn, soybeans (for hay), wheat. Losses tended to be lower in the continuous wheat plots than in plots under rotations including row crops and legumes in addition to wheat.

Differences between losses of nitrogen and organic carbon under the different fertility treatments were small. However, losses were greatest under phosphate, and phosphate and potash treatments, and were smallest under the complete fertilizer treatment.

Although alfalfa increased the nitrogen content of the subsoil slightly, the other crops in the rotation reduced it so that the rotation studied did not appreciably change the subsoil nitrogen content.

Paper No. 605, Dept. Agron., Kans. Agr. Expt. Sta., Manhattan, Kans.

Strickling, E. EFFECT OF CROPPING SYSTEMS AND VAMA ON SOIL AGGREGATION, ORGANIC MATTER, AND CROP YIELDS. Soil Sci. 84: 489-498. 1957.

The effects of thirteen cropping systems on crop yield, soil aggregation, and soil organic matter content on Beltsville silt loam were studied from 1952 to 1956. Half of each plot was treated with VAMA soil conditioner and all plots received annual applications of fertilizer equivalent to 100 pounds of nitrogen, 120 pounds of  $P_2O_5$ , and 120 pounds of  $K_2O$ . Significant changes in soil organic matter and soil aggregation occurred during the experiment. Continuous wheat, bluegrass, and ladino clover-orchard grass pasture increased soil aggregation and organic matter. Continuous soybeans, corn, and bare fallow reduced soil aggregation and organic matter content. Changes produced by other cropping systems were small since the land had been in a corn, wheat, hay rotation for a period of 12 years before the start of this experiment. Changes in soil organic matter content were accompanied by similar changes in soil aggregation. The effectiveness of the VAMA soil conditioner decreased during the 4-year period covered by this experiment. VAMA increased the yield of field corn, sweet corn, and spring oats. It had no effect on yields of wheat, soybeans, bluegrass, ladino clover-orchard grass pasture, and alfalfa hay.

Md. Agr. Expt. Sta., College Park, Md.

Hoff, D. J., and Mederski, H. J. GIVE CORN ELBOW ROOM. Ohio Farm and Home Res. 44: 52. 1959.

Corn planted in rows spaced 40 inches apart is easy to cultivate and harvest but it doesn't produce the best yield. Field experiments show that with the normal 42-inch row spacing there may be too much crowding in the row and too much space between rows.

Equidistant spacing of 18 1/2-inches between plants in the row and between rows, was compared with the conventional spacing of 42 inches between rows and 8 1/3 inches between plants in the row. Both systems gave 18,000 plants per acre.

In one experiment equidistant spacing produced 133 bushels per acre, a gain of eight bushels over 42-inch row corn, increased the number of ears from 75 to 85, decreased the number of nubbins by one-half, and increased fodder production from 2.1 tons to 2.5 tons.

It may be due to reduced competition between plants for water and minerals. Then too, equidistant planting shades the soil surface more uniformly, reduced its temperature and may reduce evaporation of soil water.

Although equidistant planting has a yield advantage, additional research now underway on weed control and tillage is necessary before equidistant planting can be recommended. On some soils it may be practical to combine minimum tillage methods with equidistant planting and then control weeds with herbicides. Present corn picking methods would have to be modified to accommodate narrow rows. In practice, narrow rows spaced about 24 inches apart would have the advantage of equidistant planting but would simplify tillage and harvesting.

Ohio Expt. Sta., Wooster, Ohio.

Laws, W. D., and Simpson, B. J. GRAIN SORGHUM IN FARMING SYSTEMS FOR THE BLACKLANDS. Hoblitzelle Agr. Lab. Tex. Res. Found. B. 8, 22 pp. 1959.

The results of eleven years of experiments on fertilizer trials on continuous grain sorghum and crop rotations including grain sorghums are presented.

The results are as follows:

1. All the rotations, whether fertilized or not, produced significantly more grain sorghum than the continuous sorghum not fertilized. The wheat-cotton-grain sorghum rotation not fertilized averaged 466 pounds more grain sorghum per acre over an eleven-year period than the continuous grain sorghum.
2. Of the nine other systems, only five gave grain sorghum yields significantly better than the system of wheat, cotton, and grain sorghum not fertilized.
3. The data indicate that fertilizer in the farming systems was more important in grain sorghum production than crop rotation. As long as the fertilizer application was equal, it made little difference whether the non-row crop was wheat, Hubam clover or grass sod.
4. Sod-sod-cotton-sorghum (fertilized) gave the highest yield followed by wheat-cotton-sorghum (fertilized).

Hoblitzelle Agr. Lab., Tex. Res. Found, Renner, Tex.

Smith, R. J., Jr., Hinkle, D. A., and Williams, F. J. PRE-HARVEST DESICCATION OF RICE WITH CHEMICALS. Ark. Expt. Sta. B. 619, 16 pp. 1959.

Investigations were conducted at the Rice Branch Experiment Station, Stuttgart, during five years to determine the effects of desiccants on rice.

In these studies, sodium chlorate at 2 gallons per acre and magnesium chlorate at 7/8 gallon per acre increased drying of grain when applied to rice containing 21 to 31 percent moisture. Although endothal and sodium monochloroacetate increased drying of grain, they are unacceptable as desiccants because they reduced head rice yields and quality. DEF was ineffective in drying of grain.

Sodium chlorate and magnesium chlorate reduced moisture content of grain by about 1 percent per day. The loss of moisture from the grain was dependent on weather conditions, especially relative humidity. Under conditions of these investigations rice treated with these two chemicals could be combined within six days after treatment.



Pre-harvest chemicals desiccated rice leaves but did not reduce greatly the moisture content of stems.

Application of desiccants reduced head rice yields, which is more serious from a milling standpoint than from a seed standpoint.

Combine losses were practically unaffected by applications of desiccants to rice.

Germination was unaffected by the desiccants used in these investigations.

Sodium chlorate and magnesium chlorate did not alter the bushel weight of rice, but endothal applied at 2 gallons per acre reduced bushel weight.

Desiccants applied to lodged Rexark, Zenith, and Bluebonnet 50 rice increased ease of combining, but lodged Arkrose rice sprayed with desiccants was difficult to combine.

The data indicate that the chemical should be applied when the average grain moisture is 24 to 26 percent.

These investigations indicate that the advantage of the pre-harvest treatment may be insufficient to justify the cost of the chemical and its application under normal harvest conditions. However pre-harvest treatments may be advantageous under the following conditions: when rice matures slowly or unevenly in the field, when the rice is lodged, and when weeds are excessive in the field. Relative humidity must be sufficiently low after treatment to permit loss of water from the rice.

U. Ark. Agr. Expt. Sta., Fayetteville, Ark.

Haddock, J. L. YIELD, QUALITY, AND NUTRIENT CONTENT OF SUGAR BEETS AS AFFECTED BY IRRIGATION REGIME AND FERTILIZERS. J. Amer. Soc. Sugar Beet Technol. 10(4): 344-355. 1959.

A study was made of sugar beets grown in a crop rotation of canning peas, alfalfa, potatoes, and sugar beets which was established at Logan, Utah, in 1949 on Millville loam. The method of irrigation, soil moisture condition, and fertilizer treatments (both residual and currently applied) were studied with relation to yield, quality and nutrition. The following results were obtained:

1. Sprinkle irrigation increased the yield of sugar beet tops, top: root ratio, and nitrate-nitrogen content of petioles but decreased purity percentage when compared to furrow irrigation.
2. Increasing soil moisture condition favored high yield of roots, high sucrose, purity, and phosphorus content of petioles and decreased top growth, top: root ratios, nitrate-nitrogen, and sodium content of petioles.
3. One-year residual phosphorus fertilizer was as effective in increasing yield of roots, phosphorus content of petioles, and available soil phosphorus as currently applied phosphorus. Four-year residual phosphorus was effective in decreasing top: root ratio and in increasing the phosphorus content of petioles and available soil phosphorus.
4. A strong interaction was observed between current season nitrogen fertilization and soil moisture condition as these affect yield of sugar beets roots.
5. The yield of sugar beet tops appears to be negatively related to sucrose and purity percentages and positively related to nitrate-nitrogen content of sugar beet petioles.
6. While the data are not conclusive they lend tentative support to the use of 25 parts per million (50 pounds per acre six inches of soil) of sodium bicarbonate soluble phosphorus as a minimum level of available phosphorus for the growing of sugar beets on calcareous soils similar to Millville loam.

SWCRD, ARS, USDA, and Utah Agr. Expt. Sta., Logan, Utah.

Haddock, J. L. Smith, P. B., Downie, A. R., Alexander, J. T., Easton, B. E., and Jensen, V. THE INFLUENCE OF CULTURAL PRACTICES ON THE QUALITY OF SUGAR BEETS. J. Amer. Soc. Sugar Beet Technol. 10(4): 290-301. 1959.

During the period 1936 to 1956 yields of sugar beets have increased and quality has decreased in most sugar beet growing areas.

In 1939 the recovery of refined sugar on beets sliced in the United States, amounted to an average of 92.7 percent. In the last year of record, 1955, it was exactly five percent less. This means a serious reduction in the quantity of sugar extracted, and naturally results in substantial economic losses.

A large number of farming practices influence beet quality. Most of the practices which affect quality also affect available soil nitrogen and nitrogen concentrations in the sugar beet plant. Although the precise relation of nitrogen concentration in the sugar beet plant to sugar percentage and purity is not clear, there is no doubt that a negative relation exists.

In some sugar beet growing areas natural climatic conditions provide sufficient control on factors affecting quality to produce high quality beets with little attention to cultural practices. Under these conditions major attention is given to practices which are effective in increasing yields. In most of the sugar beet growing area there is a conflict, seemingly, between practices which result in large yield and those which end in high quality. When we understand the effect of cultural practices, we can manipulate them to result in optimum yield and quality simultaneously.

Length of growing season is a limitation on high yield in most sugar beet areas. This can be extended by fall plowing and timely seedbed preparation. Quantity, time, and method of nitrogen fertilization must be adjusted to season and other cultural practices employed.

Plant population modifies slightly the need for nitrogen fertilizer. The greater the plant population the greater the need for fertilizer nitrogen.

Although mechanical harvesting has been blamed for decrease in beet quality, it can be a means of extending the growing season. When the harvest season is conducted in a systematic and orderly manner, mechanical harvesting can result in improved yields without diminishing quality.

Irrigation practice is inherently wasteful of available nitrogen. The efficiency of the irrigation system must be considered in modifying the needs for fertilizer nitrogen.

Although available nitrogen near harvest time is the key to sugar beet quality, the quantity of available nitrogen throughout the growing season plays a significant role in yield. Sugar beet quality can be improved if full advantage is taken of the limited growing seasons in most sugar beet areas, by early planting, and delayed harvesting. Although soil temperatures at harvest time in many beet growing areas exert a beneficial effect on sucrose percentage, the sugar beet grower can help by using only that quantity of commercial nitrogen, which will be completely utilized by his beet crop two to three weeks previous to harvest.

All cultural field practices except fertilization with commercial nitrogen, should be employed in such a way as to obtain the maximum yield of sugar beet roots for the season under which the grower operates. Commercial nitrogen should then be adjusted as near as possible to the precise need for maximum yield of sugar.

Numerous Charts and Graphs.

SWCRD, ARS, USDA, and Utah Agr. Expt. Sta., Logan, Utah.

Waggoner, P. E. PROTECTING PLANTS FROM THE COLD. Conn. Agr. Expt. Sta. B. 614, 35 pp. 1958.

The desire for plants out of season spurs the invention of shelters for plants. Shelters, frost protectors in the field, and heated frames or houses, are examined with particular attention to plastics.

The frost protection provided by an unheated covering was moderate, about 3° F. Surprisingly, the degree of protection was the same for shelters of diverse abilities to produce a "greenhouse" effect through the absorption of long-wave, outgoing radiation. Heating shelters 20° above the average minimum temperature outside required about 5 kilowatt-hours on 16 B.T.U. per square foot per month.

Shelters of plastic and waxed paper protected plants from frost until the minimum temperature reached 25° in a Weather Bureau shelter. Exposed plants had survived a minimum of 31°.

The yield of early tomatoes was increased by shelters in a cool spring, decreased by shelters in a warm spring.

The maximum probability of shelters providing needed frost protection is about 4 out of 10, the corresponding probability of their failing is about 1 out of 10 and of their being unnecessary is about 5 out of 10. This maximum probability of benefit is obtained if the plants are transplanted near the mean date of last occurrence of 30°.

Conn. Agr. Expt. Sta., New Haven, Conn.

Watts, V. M., and Bittle, C. M. THE HOPE DIAMOND MELON. Ark. Farm. Res. 7(1): 2. 1958.

A new variety of watermelon has been released to seedsmen by the Arkansas Agricultural Experiment Station. The fruits of this variety, which has been named Hope Diamond, are similar in appearance to Black Diamond, a variety that for many years was the most important commercially grown variety of the South.

Hope Diamond differs from Black Diamond in three major characters: (1) it is resistant of Fusarium wilt, a soil-borne disease that has become established in much of the good watermelon soil of the South and has made imperative the finding of a substitute for the susceptible Black Diamond; (2) it is resistant to anthracnose, one of the several leaf-spotting diseases that damage susceptible varieties; and (3) its fruits, in three years' trials, have been consistently superior in quality to those of Black Diamond.

Hope Diamond was chosen from a family of lines developed by single plant selection from a cross of Black Diamond by a wilt- and anthracnose-resistant breeding line. Breeding plots used in the program were so heavily infested with the Fusarium wilt organism that susceptible plants failed to survive. Seedling inoculation was used to determine anthracnose resistance.

The line chosen for release, Ark. 56-21, has bred true for wilt resistance for five generations and for anthracnose (race 1) resistance for three generations.

During the past three growing seasons Hope Diamond and its sister lines were subjected to critical production tests on typical watermelon soil. In these tests, it matured its fruits at the same season as Black Diamond. In 1955 when the test was conducted on wilt-free soil, Hope Diamond outyielded Black Diamond by less than a ton per acre. In 1956 and 1957 the trials were on wilt-infested soil, and the yields of Black Diamond were materially reduced by the disease.

Hope Diamond consistently produced the sweetest fruits. Fruits of Hope Diamond as small as 15 to 20 pounds consistently had as high sugar contents as those in any larger size range. In all trials the new variety had brighter "red" flesh than Black Diamond.

The melons of Hope Diamond have been quite free of both white heart and hollow heart. The rinds have been tough and flexible and are from 5/8- to 3/4- inch thick. Storage trials have shown that the fruits hold their eating qualities as well as do those of Black Diamond. Hauling tests have indicated that this variety has good shipping qualities.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Kattan, A. A., Horton, B. D., and McFerran, J. EFFECT OF VARIETY AND DATE OF PLANTING ON TOMATO YIELD AND QUALITY. Ark. Farm Res. 8(1): 5. 1959.

Experiments were conducted in 1958 at Fayetteville to study the effects of date of planting and variety on yield and quality of fresh-market and processing tomatoes.

Five fresh-market varieties and four processing varieties were planted on each of three planting dates: in the first weeks of May, June, and July. The seedlings were planted 18 inches apart in twin-rows; the distance between twin-rows was 18 inches for fresh-market varieties and 24 inches for processing varieties. Alleys between the sets of twin-rows were five feet wide for the fresh-market and six feet wide for the processing varieties. Plants of the fresh-market varieties were pruned to two stems with each set of twin-rows trained to a single trellis.

All plots were fertilized with 250 pounds of 10-20-10 prior to planting and sidedressed with 30 pounds of nitrogen when the first cluster was half grown. A weekly spray program with maneb was maintained throughout the season. Very little irrigation was applied in 1958 to maintain available soil moisture above 50 percent.

The time of planting was the most important single factor affecting yield, which decreased sharply with delay in planting. Contrary to common belief, distribution of



yield was not affected by delaying the planting date, within practical limits. October harvest was increased only when planting was delayed to July; this was accompanied by a substantial sacrifice in total yield. Distribution of yield was primarily a function of variety with Pinkshipper being the latest of all fresh-market varieties under study.

Among fresh-market varieties, Homestead 24 and Big Boy were superior in total marketable yields, and also had the lowest percentage of radial cracking, which was a major problem to the fresh-market tomato industry in Arkansas in 1958. Big Boy also produced the largest sized fruits which were highest in color, soluble solids, and pH, and lowest in firmness.

Among the processing varieties, Kokomo and Urbana gave the highest total marketable yields and also had the lowest percentage of cracking, with Urbana being the earliest of all four varieties. These two varieties produced smaller fruits that were less firm but higher in color than fruits of Rutgers and Indark.

These results indicate that highest marketable yields are obtained only from early plantings. High late season yields do not result from delayed planting except when planting is delayed till July, which will reduce total yields considerably. This would not be economically feasible with processing tomatoes. Whether it would be feasible with fresh-market tomatoes will depend on the prices encountered for late tomatoes.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Bradley, G. A., and McFerran, J. TOMATO VARIETY, PRUNING, FERTILIZER, AND LIMING EXPERIMENTS ON COASTAL PLAIN SOILS, 1955-1957. Ark. Agr. Expt. Sta. B. 596, 26 pp. 1958.

Experimental work on tomatoes was conducted in Bradley County in southeastern Arkansas during 1955, 1956, and 1957 on three soil types fairly typical of those used for tomatoes in the area. These trials included variety comparisons, pruning and mulching studies, and liming and fertilizer tests.

In variety trials the Pinkshipper variety compared favorably with Gulf State Market in overall performance. It has the added advantage of Fusarium wilt resistance.

Pruning trials pointed out the wide variations in the effect of pruning methods during different seasons and on different soils. The single stem method of pruning was not as satisfactory as the other systems used. Differences between the single stem, tipped and the two stem systems were not very great, but a slight advantage appeared for the two stem method. The unpruned method compared favorably with the other pruning systems, but practical considerations may limit its usefulness. The unpruned system proved to be outstanding in marketable yields on the Ruston soil in both seasons. Cracking was a serious problem on this soil, but cracking was least serious on the unpruned plants.

There were interactions between pruning and the use of sawdust mulch in some cases, with the unpruned treatment having the highest total yield where mulch was used and the two stem system having the highest total yield when no mulch was used.

On the Ruston soil with a pH of 5.1 to 5.2, liming resulted in significant increases in marketable yields in 1955 and 1956. The increase was due to a larger number of marketable fruit which was related definitely to less blossom-end rot on fruits from the limed plots in 1956. On the Cahaba soil with a pH of 6.2, there were no effects from liming.

Calcium chloride sprays did not significantly affect yields in 1957 in a field where blossom-end rot was not a problem.

The best nitrogen application varied at different locations. In general, applications of 25 to 50 pounds an acre under the row and a sidedressing of 30 to 60 pounds appeared to be adequate.

Response to phosphorus was obtained on all soils although the best level to use was not definitely established. On the Cahaba soil, a 1 to 2 ratio of nitrogen to  $P_2O_5$  in the fertilizer gave better results than a 1 to 1 ratio. On the soils used, 80 to 100 pounds available  $P_2O_5$  by soil test was not adequate phosphorus for tomatoes.

There was no response to potassium additions on soil testing 240 to 280 pounds available  $K_2O$  per acre. Total yields were increased by potassium additions on the soil testing 100 pounds available  $K_2O$ , but marketable yields were not affected.

There were no significant effects of fertilizer applications with respect to occurrence of cull fruit.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Shear, G. M., and Miller, L. I. INFLUENCE OF TIME OF PLANTING AND DIGGING ON THE JUMBO RUNNER PEANUT. Agron. J. 51: 30-32. 1959.

Experiments to determine the effect of time of planting and digging on yield and quality of the Holland strain of Jumbo Runner peanut were conducted over a 5-year period at Holland, Va.

The early-planted peanuts required more time between planting and digging to reach maximum levels of shelling percentage and percentage of extra large seed than did the later-planted ones. The minimum time necessary for Jumbo Runner peanuts to reach maximum levels of both shelling percentage and percentage of extra large seed was 148 days, for peanuts planted May 22.

Maximum yields were reached before maximum shelling percentage or maximum percentage of extra large seed was obtained. Maximum levels of extra large seed were reached sooner for peanuts planted April 22 than were maximum levels of shelling percentage.

Regardless of when this variety was planted, it did not reach optimum maturity before October 15.

The early-planted peanuts were slower reaching the flowering stage than were the later-planted ones and this is an important factor in the time required from planting to digging to obtain maximum levels of mature fruit.

Seasonal variations in temperature and rainfall have a marked effect on yield and quality of peanuts. High temperature and moderately low rainfall, as related to normal for the area, appear to favor high yield and high quality.

Va. Agr. Expt. Sta., Blacksburg, Va.

Bradley, G. A., and Mayes, R. L. SWEET POTATOES FOR THE NORTHEAST DELTA. Ark. Farm Res. 8(5): 5. 1959.

Sweet potatoes have been grown to only a minor extent on Delta soils in northeastern Arkansas. Interest by growers prompted initiation of fertilizer and variety tests in 1958 at Wilson on soils that were being used for commercial sweet potato production.

Replicated experiments were conducted on two soil types in 1958 and 1959. The Tunica silty clay soil contained 2.0 percent organic matter and the Clack sandy loam soil tested 2.4 percent organic matter. Both soils were high in phosphorus and very high in potassium and calcium. The pH of these soils ranged from 7.0 to 7.3.

The varieties were fertilized with 15 pounds N, 30 pounds  $P_2O_5$ , and 60 pounds  $K_2O$  in all tests. Allgold was generally the highest yielding variety. However, a considerable percentage of the Allgold yield was often of the jumbo size.

The percentage of jumboes in Acadian was about the same as for Allgold, but yields were usually lower. Copperskin Goldrush, although generally lower than Allgold in total yield, had a smaller percentage of jumbo size.

Some guides to fertilization may be drawn from these tests. On soils testing high in phosphorus and potassium, response to these elements is unlikely. Soils testing lower should be given applications of 30 to 60 pounds per acre depending on soil test. A light application of nitrogen may be justified on all soils as a safety precaution since soil test methods do not give a good measure of residual nitrogen. This application may range from 15 to 60 pounds per acre depending on organic matter content and fertilization of the previous crop. The probability of over-winter leaching of nitrogen should also be considered. These applications may all be made under the row or in the bed before transplanting.

Good yields of sweet potatoes may be expected on a wide variety of soil types in the Delta area. A major precaution would be to avoid soils with inadequate drainage. The only instance of low yields in these trials was related to high rainfall and imperfect drainage.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Wolfenbarger, D. O. CONTROL OF INSECTS AND OTHER PESTS OF TOMATOES, PEPPERS AND EGGPLANTS. Fla., Agr. Expt. Sta. C. S-116, 36 pp. 1959.

Florida growers probably face more hazards in growing vegetables than do growers in any other state. Tomatoes, peppers and eggplants are grown in various parts of the state. A crop can never be grown successfully without some attention to pest control. Insect damage is a production hazard and controlling insect pests is a year-round problem. Control of insect pests is complicated by disease control, which also is required for efficient crop production. In an efficient plant protection program the insecticide and fungicide must be compatible--function as well combined as separately.

Pest control in Florida is on a high level of efficiency as a result of new organic insecticides and improved methods of application. Improved pest control has raised the standard of products by producing a crop free of insect fragments and insect-produced blemishes, lowered the cost of production and resulted in a more uniformly matured product.

Control measures of insects and other pests of tomatoes, peppers, and eggplants in Florida are presented.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Cox, R. S. ETIOLOGY AND CONTROL OF CELERY DISEASES IN THE EVERGLADES. Fla., Agr. Expt. Sta. B. 598, 27 pp. 1958.

The celery industry of the Everglades is confronted with several important diseases including those initiating below the soil level (red root, root knot, and *Fusarium* yellows), as well as several above-ground (damping-off, early blight, bacterial blight, late blight, and anthracnose). Supplementary information on the symptomatology and etiology of the diseases is presented. (*Fusarium oxysporum* f. *apii*) was the fungus most frequently associated with early post-emergence damping-off, red root and yellows, and this fungus produced symptoms characteristic of these diseases on celery under greenhouse conditions. (*Pythium* sp. (p)) was associated much less frequently with these diseases. In the greenhouse isolates of (*Pythium*) produced more of a soft watery rot (damping-off) than red root or yellows-type symptoms. The possibility of ectoparasitic nematodes playing a role in the etiology of red root is suggested. (*Rhizoctonia solani*) was the dominant organism associated with late post-emergence damping-off.

In the seedbed methyl bromide and chloropicrin consistently gave better control of red root, root knot and yellows than other fumigants or particulate materials tested. Formaldehyde gave good control of yellows, but failed to control red root. None of these provided adequate control of *Rhizoctonia* damping-off, but several particulate materials as foliar sprays did. These include chloranil, ferbam, PCNB, the neutral coppers, and thiram.

In the seedbed zineb or maneb provided the most effective protection against early blight; the neutral coppers or streptomycin against bacterial blight; and the neutral coppers or a mixture of zineb and thiram against anthracnose.

Mixtures of chloranil-zineb-streptomycin, neutral copper-zineb-streptomycin or thiram-zineb-streptomycin were highly effective against all the foliar diseases in the seedbed (damping-off, early blight, bacterial blight and anthracnose). The first two mixtures caused light to moderate plant injury under certain conditions.

Under field conditions Dyrene showed particular promise against early blight. Thiram was most effective against *Rhizoctonia* stalk rot. Zineb was intermediate against early blight and inferior against *Rhizoctonia* stalk rot. Maneb, thought better than zineb, also failed to provide maximum protection against either disease.

Several mixtures looked promising. Zineb and thiram in mixture appeared to be synergistic in their action against early blight. Maneb plus thiram also was effective. Tribasic copper sulfate plus Dyrene was particularly outstanding against early blight. All these mixtures were also quite effective against *Rhizoctonia* stalk rot.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.



Eden, W. G., and Ingram, J. W. FIVE YEARS OF COOPERATIVE RESEARCH ON CONTROL OF THE CORN EARWORM IN SWEET CORN. U.S.D.A., A.R.S., 33-52, 10 pp. 1959.

The corn earworm (*Heliothis zea* (Boddie)) has caused more damage to sweet corn than any other insect. It has also been the most difficult to control. Since DDT became available, good earworm control has been both possible and practicable, but the degree of control has varied by years and areas.

To determine the variation in control by areas, as a basis for control recommendations, a Federal-State cooperative project, called the National Corn Earworm Experiment, was begun in 1952 and conducted annually through 1956. The following phases of earworm control were investigated: (1) effectiveness of mineral oils when used with DDT, (2) effects of different dosages of DDT with and without mineral oil, (3) effects of timing and number of applications of DDT-mineral oil sprays, and (4) influence of intervals between applications of DDT sprays.

Corn earworm infestations in sweet corn varied considerably in different locations and years. Every DDT or DDT-mineral oil spray program used during the 5-year period significantly reduced the infestation. The effectiveness of sprays frequently varied from location to location. The addition of mineral oil to DDT increased the earworm control. There was no correlation between the viscosity or specific gravity of the mineral oil and earworm control when used with DDT. There was a positive correlation between the amount of unsulfonated residue in the mineral oil and earworm control. Increasing the rate of DDT by 1/2-pound increments, either with or without mineral oil, from 1 to 2 1/2 pounds per acre gave a significant increase in control. DDT at 2 1/2 pounds per acre gave approximately the same control as 1 1/2 pounds with 1 3/4 gallons of mineral oil. When sweet corn was sprayed six times at 2-day intervals with 2 pounds of DDT plus 1 gallon of mineral oil per acre, there was no significant difference in control when the spray program was begun the first or the second day after the first silks appears. When the intervals between applications was constant throughout a 14-day spray period, the control was inversely proportional to the length of the interval. Increasing the interval between applications in either half of the spray period, when followed or preceded by daily spraying, reduced earworm control below that obtained with daily spraying. A close-interval spray program was more important during the first part of the protection period than during the latter part.

ARS, USDA, Inform. Div., Washington 25, D. C.

Cox, R. S., and Harrison, D. S. FACTORS AFFECTING THE INCIDENCE AND CONTROL OF NORTHERN CORN LEAF BLIGHT IN SWEET CORN PRODUCTION IN THE EVERGLADES. Fla. Agr. Expt. Sta. B. 596, 20 pp. 1958.

The severity of northern corn leaf blight during the spring seasons of 1955, 1956 and 1957 was related to mean weekly minimum temperature, mean weekly minimum relative humidity, and frequency of rains. Disease was checked when the weekly mean minimum temperature was less than 60° F., the mean weekly minimum relative humidity less than 60 percent, and when rains occurred less frequently than at weekly intervals.

Nozzle Placement.--Two nozzles directly over the row were superior to one from the standpoint of both disease control and yield. Beneficial effect of drop nozzles was not as striking as that of the overhead placement, but an increase in disease control was obtained as the drop nozzles were increased from one to three spaced on 15-inch centers.

Gallage.--With a given concentration, more gallons per acre for control are required under severe disease conditions than under mild or moderate conditions. Where 150 gallons per acre would be adequate under moderate conditions, 250 gallons per acre might be necessary for most effective control under severe conditions of disease.

Materials.--Based on performance and cost, the order of preference of the more effective materials is as follows: maneb, zineb plus thiram, zineb, nabam plus zinc sulfate or Amobam and Dyrene. Parzate (zineb) appeared to be more effective than Dithane Z-78.

Plytotoxicity. --The neutral coppers caused a severe contact burn and the antibiotics tested caused light to severe chlorosis, stunt and lodging. Under conditions or prolonged free moisture maneb, nabam (plus salts) and zineb-thiram mixtures caused a contact burn when applied to young plants with leaves still in the whorl.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Entomology Research Division. THE MEXICAN BEAN BEETLE IN THE EAST AND ITS CONTROL. U.S.D.A., Farm B. 1624, 15 pp. 1958.

The Mexican Bean Beetle is the most serious insect enemy of beans in those parts of the United States that it inhabits. It has long been present in the Southwestern States.

The Mexican bean beetle is a copper-colored, round-backed beetle with 16 black spots on its back. It is about 1/4 inch long and about 1/5 inch wide. The beetle resembles some of the native beneficial ladybirds.

The larva, or immature form, is lemon-colored, varies in length from about 1/20 inch when young to about 1/3 inch when full grown, and is covered with branched spines, which give it a fuzzy appearance.

Injury done to the bean plant by the young and adult of the Mexican bean beetle is different from that caused by other insects which feed on the beans. The adult, feeding from below, eats ragged areas in the lower surface of the leaf, but often cuts through the upper surface, giving the foliage a lacelike appearance. The larvae also feed on the under surface of the leaf, but do not cut through the upper surface. The lower tissue is scraped up and compressed by the mouth parts as the juices are swallowed. The solid material is left on the leaf in small windrows or strips, so that the result is a peculiar network characteristic of the work of this insect.

The leaves are attacked first, but both beetles and larvae will feed on the young pods if the leaves have been destroyed or have become tough and unpalatable. They may even eat the stems. When insects are numerous, an injured plant appears completely dried out.

This Farmers' Bulletin gives the life history and habits of the Mexican beetle and how they can be controlled by spraying, natural control and cultural control.

ARS, USDA, Inform. Div., Washington 25, D. C.

Reid, W. J., Jr., and Cuthbert, F. P., Jr. CONTROL OF CATERPILLARS ON COMMERCIAL CABBAGE AND OTHER COLE CROPS IN THE SOUTH. U.S.D.A., Farm. B. 2099, 24 pp. 1957.

The feeding of caterpillars on cabbage and other cole crops reduces the income of southern growers by millions of dollars each year. The losses are accounted for in part by damaged crops--lower yields and lower quality--and in part by the cost of combating these insects.

Cole crops other than cabbage that are attacked by caterpillars in the South are broccoli, cauliflower, collards, and kale. Brussels sprouts and kohlrabi are also attacked by caterpillars, but are not grown extensively in the South.

The caterpillars can be controlled by applying insecticides, but no single insecticide will control all of them. In order to select effective insecticides, you must be able to identify the caterpillars attacking your crop.

This bulletin illustrates and describes the 13 kinds of caterpillars that damage cabbage and cole crops in the South along with recommended methods of control.

ARS, USDA, Inform. Div., Washington 25, D. C.

Stephenson, K. O. MECHANIZED WEED CONTROL IN COTTON. Ark. Farm Res. 8(3): 6-7. 1959.

A recent development that permits early flame cultivation of cotton has substantially reduced the man-hours of hoe labor required to maintain clean fields. Research results show that early flaming in combination with pre- and post-emergence chemicals can reduce hoe labor as much as 75 percent in most cases; when field conditions are favorable, weeds can be controlled entirely by mechanized methods. Such reductions represent 30 to 40 man-hours per acre during years of severe weed infestations.

The most reliable mechanized system of weed control for Arkansas cotton growers is a flexible, four-phase program consisting of: (1) a pre-emergence chemical application, (2) post-emergence herbicidal oil applications, (3) flame cultivations, and (4) sweep cultivations. When properly applied, these practices will help cotton farmers achieve more efficient production.

Pre-emergence chemicals are not effective every season. However, their effectiveness cannot be determined in advance and it is advisable to apply the treatment each year. Oil and flame are used as necessary to control weeds. Weed infestations vary widely and the number of oil and flame applications needed will vary accordingly. Sweeps or other cultivating tools are used as required in conjunction with oil and flame applications, or separately, to maintain clean middles.

Maximum benefit from mechanized practices requires adequate drainage so that machinery operation is not delayed unduly by low, wet areas and pot holes. The effectiveness of oil applications, in particular, depends largely on proper timing. Seedbed preparation is also important--best results are obtained with smooth, uniformly shaped, low-profile beds. Adequately drained fields and uniform beds tend to give uniform seedling emergence which is important for successful oiling and early flaming.

The completely mechanized system of weed control has several limitations. Of primary concern has been the lack of dependable control during the period when herbicidal oil cannot be used and the cotton plants are too small to flame. Often vines and other perennial weeds are not controlled by the pre-emergence treatment. If bad weather prevents timely applications of oil during this period, or if the bark on the cotton stalks has begun to crack and prohibits the use of oil, weed growth usually gets out of control before the conventional method of flame cultivation can be used safely.

A recent development in the use of flame cultivation makes control possible during this period. Excellent weed control has been obtained by setting the burners parallel to the drill. This permits early flaming when cotton plants are four to six inches tall with negligible burn damage. The parallel burner setting has several distinct advantages over the conventional method of cross flaming: (1) it can be applied earlier; (2) larger weeds can be killed over a wider area of the row; and (3) the precision of the burner settings and the smoothness of the row are less critical.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Smith, Roy J., Jr. CHEMICAL CONTROL OF BARNYARD GRASS IN RICE. Ark. Farm Res. 7(2): 2. 1958.

Barnyard grass (Echinochloa crusgalli) is one of the most serious weeds affecting rice production in Arkansas.

During 1955, 1956, and 1957 cooperative studies between the U. S. Department of Agriculture and the Arkansas Agricultural Experiment Station were conducted at the Rice Branch Experiment Station, Stuttgart, to find a chemical method for controlling barnyard grass in rice.

A preliminary investigation in 1955 indicated that when CIPC (isopropyl N-(3-chlorophenyl carbamate) was applied to drill-seeded rice just prior to rice emergence, it gave excellent control of barnyard grass without injury to rice.

The investigations in 1956 were expanded to study the effect of time and rate of application of CIPC on the control of barnyard grass and the response of rice to the treatments.

CIPC applied just prior to emergence of the rice or when the rice was in the first leaf stage of growth gave excellent control of barnyard grass with the least injury to rice. When rice was treated with CIPC in the first leaf stage of growth, the average yield for all rates of application was 86 bushels per acre, while the untreated check plots yielded only 34 bushels per acre--an increase of 52 bushels from the treatment.

The plots that were treated with CIPC when 20 to 30 percent of the rice had emerged were flushed with irrigation water immediately after herbicidal treatment. This treatment. This treatment appeared to reduce the rice stand in 1956.

In 1957, the studies were expanded to evaluate the effect of irrigation immediately after herbicidal application on injury of CIPC to rice.



In these studies applying irrigation water in varying amounts and at different times after the CIPC treatment did not influence effect of CIPC on rice or efficiency of the herbicide in controlling barnyard grass. As the rate of application of CIPC was increased from 0 to 10 pounds per acre, control of barnyard grass increased from 0 to 98 percent. The rice yield ranged from 56 bushels per acre in the untreated check plots to 100 bushels per acre when CIPC was applied at 10 pounds per acre, or an increase of 44 bushels from the CIPC treatment.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Day, B. E., Johnson, E., and Dewlen, J. L. VOLATILITY OF HERBICIDES UNDER FIELD CONDITIONS. Hilgardia 28: 255-267. 1959.

Herbicidal formulations of 2, 4-D, 2, 4, 5-TP, and amino triazole were tested for volatility under high summer temperature conditions in the Coachella Valley, California. The herbicides were applied to plots in cotton fields and the degree and extent of injury to surrounding cotton plants served as a measure of the volatility of the herbicides. Formulations of 2, 4-D were found to be increasingly volatile in the order amine salts, acid, and low-volatile esters. It was determined that vaporization of the herbicides occurred predominantly during the daytime. A low volatile formulation of 2, 4, 5-TP appeared to be as volatile as similar formulations of 2, 4-D but produced only minor injury symptoms on cotton. Amino Triazole appeared to be entirely free of volatility hazard.

Calif. Agr. Expt. Sta., U. Calif., Berkeley, Calif.

### Crop Residue Management

Munson, R. D., and Pesek, J. T. THE EFFECTS OF CORN RESIDUE, NITROGEN, AND INCUBATION ON NITROGEN RELEASE AND SUBSEQUENT NITROGEN UPTAKE BY OATS: A QUANTITATIVE EVALUATION. Soil Sci. Soc. Amer. Proc. 22: 543-547. 1958.

A fertile Clarion loam soil was treated with rates of corn residue and nitrogen and incubated at approximately 30° C. for different periods under controlled moisture conditions. After incubation, half of the treated soils were leached to remove the soluble nitrogen. Inorganic nitrogen determinations on the leachate were used to study the effects of the treatments on nitrogen release.

Regression equations were used to express inorganic nitrogen yield as a function of time. The first derivatives of these equations were used to estimate the time, in days, at which the "maximum" inorganic nitrogen immobilization or minimum amount of soluble nitrogen occurred for each level of nitrogen. These time values were used to estimate the maximum quantities of nitrogen immobilized at each nitrogen level. The results indicate that in fallow-incubated soils that had received residue, the "maximum" quantity of inorganic nitrogen immobilized increased as the quantity of applied nitrogen was increased. However, after the estimated minima of the curves were passed, the net rate of mineralization also increased with the rates of nitrogen.

The leached and unleached soils were cropped with oats, which was harvested at the boot stage. Dry matter yield and nitrogen yield curves were used to evaluate the various treatment effects. The results indicate marked responses to the residue, nitrogen, incubation, and leaching treatments. The various yield curves indicate that the immobilized nitrogen was released to the crop.

The leaching technique used in this experiment is shown to be an excellent method for evaluating net nitrogen transformations. This technique may have applicability in studying other mobile soil nutrients and also, the effects of applied fertilizers on the release of other soil or fertilizer nutrients.

Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Walker, T. W., and Adams, A. F. R. STUDIES ON SOIL ORGANIC MATTER: 2. INFLUENCE OF INCREASED LEACHING AT VARIOUS STAGES OF WEATHERING ON LEVELS OF CARBON, NITROGEN, SULFUR, AND ORGANIC AND TOTAL PHOSPHORUS. Soil Sci. 87: 1-10. 1959.

Soils formed from graywacke or graywacke loess and classified according to their degrees of weathering and leaching have been analyzed by genetic horizons for carbon, nitrogen, sulfur, organic and total phosphorus. Volume weights of each horizon were also determined.

In the weakly weathered sequence, total phosphorus per unit area of profile decreased with increased leaching, but this was due mainly to decreasing volume weight occasioned by higher levels of organic matter, and little if any phosphorus was lost by leaching. The percent organic phosphorus of the total was low in the areas of low rainfall and increased to about 90 percent in the wettest area.

In the moderately weathered sequence there was evidence of loss of phosphorus from the most leached members and large amounts were definitely lost from the strongly leached, strongly weathered soils. In addition to possible losses of phosphorus by erosion of the enriched A horizons, phosphorus may also be leached from the solum in the organic form, and from soft weathering rock in the inorganic form.

Actual weights of organic phosphorus per unit area of profile reach a peak at intermediate stages of leaching and weathering and, because of the interrelation between carbon, nitrogen, sulfur, and organic phosphorus, organic matter levels follow the same pattern as organic phosphorus, being low in weakly leached, weakly weathered soils and high in intermediate stages, falling again in strongly leached, strongly weathered soils. Because of wide variations in the C:N:S: organic P ratio, the individual elements C, N, and S may, however, be out of phase with organic phosphorus. Variable returns of cyclic sulfur may also complicate the pattern. In the humid tropics and subtropics, organic matter levels should be high in the earlier stages of development and fall with increasing maturity.

Charts, Graphs and 21 References.

Canterbury Agr. Col., Lincoln Col., Christchurch, New Zealand.

Power, J. F., Aasheim, T. S., and Hartman, G. P. SPRING WHEAT PRODUCTION AND SOIL AND WATER CONSERVATION AS INFLUENCED BY METHODS OF SUMMER FALLOWING ON A CHESTNUT SOIL IN NORTHEASTERN MONTANA. Soil Sci. Soc. Amer. Proc. 22: 460-463. 1958.

Five methods of summer fallowing commonly employed in the spring wheat producing area of Montana were evaluated in respect to their effects on grain yield and quality, and on soil and moisture conservation. This study was conducted under dryland conditions on a Chestnut soil during the period 1949 to 1956.

During seasons of normal or above-normal growing conditions, grain yields were not significantly influenced by the method of fallowing employed the previous summer. Under poor growing conditions, grain yields were generally highest on plowed fallow.

Protein content of the grain was slightly lower on stubble-mulch than on plowed fallow. Test weights of the grain were highest on stubble-mulch fallow. Other fallow methods were generally intermediate between plowed fallow and stubble-mulch fallow in respect to grain quality.

Soil-moisture content at seeding time was not affected by fallow method. Stubble mulching provided the best soil erosion control. Fall tillage could not be recommended from the data collected in this study.

SWCRD, ARS, USDA, Sidney, Mont.

Williams, L. E., and Schmitthenner, A. F. CROP AND ITS RESIDUES LIMIT DISEASE. Ohio Farm and Home Res. 44: 61. 1959.

Don't destroy your crop residues such as stubble and straw. They can help defend your crops against diseases.

Even the growing crops themselves sometimes reduce the amount of disease. In studies of soil-borne crop blights at the Ohio Agricultural Experiment Station, alfalfa seedling blight was not as bad following crops of soybeans or corn as after oats, wheat, or alfalfa. And wheat seedling blight was not as severe when oats or soybeans preceded wheat as when this grain was grown in succession.

A partial explanation for the reduction in soil-borne diseases under a rotation setup is that when crops are planted which disease organisms cannot attack they are starved out. On the other hand, under continuous cropping the disease organisms may build up to epidemic proportions.

Even though a crop may be susceptible to attack by a disease organism, the crop may still decrease the amount of this organism in the soil by favoring the build-up of harmless, or helpful fungi. These fungi can be beneficial by starving out or poisoning the disease-causing organisms. There is a continual battle raging between these harmful and beneficial organisms. The most practical way then to build up the friendly organisms is by using a favorable crop rotation or by plowing down crop residues.

Ohio Agr. Expt. Sta., Wooster, Ohio.

American Society of Agronomy, MULCH TILLAGE - A REPORT ON ITS PRESENT STATUS IN THE EASTERN UNITED STATES. Crops and Soil pp. 11-13. Feb. 1958.

Mulch tillage has become a well established practice in the Great Plains, but in the more humid regions, its use is lagging even though its value for soil conservation is widely recognized.

This article gives the status of mulch tillage throughout the eastern half of the United States.

J. H. Lillard of the Virginia Polytechnic Institute describes a method of "double cut plowing" which completely inverts the 0 to 3 inch soil layer and subtils without turning the 3 to 7 inch zone. Several weeks later when the final seedbed is prepared, the dead sod is returned to the surface as the protective mulch cover. Its chief benefit is soil and water conservation.

M. B. Russell of the University of Illinois points out that with mulch tillage, corn yields in Illinois rarely exceeds and frequently fall below those under conventional practices. The increased retention of water is often a definite disadvantage, particularly on imperfectly drained soils. On such soils, seedbed preparation and planting may be delayed and early growth of corn may be slow, probably because of lower soil temperatures and reduced availability of plant nutrients.

W. E. Larson of the U. S. D. A. at Iowa State College states that mulch tillage still offers the most all around soil and water protection on corn land of any of the tillage methods proposed. Mulch tillage for corn in Iowa is practiced by using large 24 or 30 inch sweeps that loosen the soil, but leave most of the residue on the surface. It has been best suited to the medium and coarse textured soil, well drained and in good physical condition and also in years of normal or below normal moisture. Difficulty has been experienced in heavy grass sods. Cultivation and weed control are more difficult when under mulch tillage, but chemical weed control lessens the problem.

O. W. Beale of the U. S. D. A. at Clemson Agricultural College writes that mulch is recognized as one of the best means of reducing erosion and runoff from cultivated land in summer when high intensity thunderstorms occur. It improves soil aggregation, and reduces puddling of the soil surface permitting more water to enter and pass through the soil. Aeration is increased by better soil structure, and tillage implements operate more easily. The key to successful mulch culture is the use of proper implements for seed-bed preparation, planting and cultivation.

James Tyson of Michigan State Universities prefers minimum tillage. Yields of corn, oats and wheat averaged 1, 14, and 8 bushels less respectfully, from 1943 to 1948 on Hillsdale sandy loam on the Universities Farm at East Lansing, Michigan, for the stubble-mulch plots when compared with the conventionally plowed and fitted plots. The failure of the stubble mulch systems to control weeds and their depressing effect on nitrification in the cold, wet spring weather characteristic of Michigan were the most serious hindrances to these methods. The plow plant plots in 1955 and 1956 produced an average of 80 bushels of corn and 42 bushels of wheat compared to 64 bushels of corn and 40 bushels of wheat on the stubble-mulch plots.



John R. Carreker of U.S.D.A. at the University of Georgia says that stubble-mulch tillage definitely cuts runoff. Runoff and soil losses were measured on a 7% slope during a 5 year rotation of oats--lespedeza, and cotton. The average annual soil losses per acre were: cotton continually, 27 tons; cotton after turned lespedeza, 6.9 tons; cotton after ripped lespedeza, 3.3 tons.

T. N. Jones and Calvin K. Mutchler from the Mississippi State College writes about seedbed requirements. Uniform spreading of mulch is highly essential for best results in planting and cultivating. Generally, mulch tillage requires heavier equipment. When, in one operation, the seedbed is prepared, fertilizers placed at two depths, and planting done, the equipment must have more strength than normal. The moisture content of the soil will greatly affect requirements of equipment.

Helmut Kohnke of Purdue University says soil type is important. Wherever erosion can not be controlled economically with other practices, mulch tillage is desirable. Numerous experiments show that mulch causes the soil in summer to be cooler, more moist, and less well supplied with oxygen than conventionally tilled soil. Indirectly mulch tillage decreases the availability of nitrogen and potash. Mulch tillage for soybeans is practically "fool proof". The soybeans have a rather shallow root system and good capacity to absorb potash and supply their own nitrogen. Mulch tillage for wheat also poses no great problem, but the mulch should not reduce the available nitrogen in the soil. Mulch tillage for corn is particularly important for erosion control, but it often has resulted in corn yield decreases, but it is possible to get as high corn yields from mulch tillage as from ordinary plow and plant method when properly tilled and fertilized.

R. R. Robinson of the U.S.D.A. at Beltsville, Maryland summarizes the problem. Techniques adapted to local conditions have been devised for initial tillage operations, fertilizer practices, planting, cultivating through the mulch, and satisfactory control of weeds and insects. Crop yields under mulch tillage are seldom higher and often are lower under conventional practices. Lower soil temperatures under mulches may be an important factor in yields, particularly in the cold, wet soils of the Northern States. The future of mulch tillage is very promising because of its value in soil and water conservation. Its use can be expected to increase greatly on sloping erosive land. At the same time, alternate conservative practices such as plow plant, and tractor-tract planting will be widely used especially on imperfectly drained soils and on fine textured soils, both of which warms up slowly in the spring.

Duley, F. L. STUBBLE MULCHING IN THE GREAT PLAINS. J. Soil and Water Conserv. 14: 7-11. 1959.

Modern American and European agriculture has developed around one primary tillage implement--the steel moldboard plow. When lands were new, or where erosion was not a big factor, most of the advantages in maintaining good tilth, controlling weeds, and providing a good seedbed were brought out by the use of this implement. With measurements on soil erosion and a greater interest in maintaining soil productivity on a permanent basis, some disadvantages of this modern type of plow were seen.

After much field experience, a complement of equipment is now available that will enable farmers to prepare a satisfactory stubble mulch seedbed for any of the crops commonly grown in the Great Plains. In addition, equipment has been developed for seeding small grain or grasses through residue and for planting and cultivating row crops.

Many types of equipment may have a valuable place in a stubble mulch program. However, the principal operations requiring special types of equipment are: (1) The main tillage operation, (2) Working down the tilled soil--the secondary tillage, (3) Drilling small grain, (4) Planting row crops, and (5) Cultivation of row crops.

One of the principles that should be most carefully followed in a stubble mulch system is to prevent the weeds from producing seed. In small grain stubble fields a shallow sub-tillage may be given at the proper time to prevent weed seed production and, at the same time, leave the stubble standing to catch snow and increase the chance for storing water in the soil.

In a stubble mulch system it is of great importance that a proper amount of residue be maintained at all times. It is possible to have too much residue on a field. There may

be so much that it is difficult to work through, and it may hinder normal biological and chemical processes in the soil. There seems to be no specific amount of residue that can be recommended, but 1,500 to 2,000 pounds per acre will give much protection to land against water or wind erosion. The amount needed will vary with the kind of residue and the extent to which it is anchored in the soil.

Yields of crops on stubble mulched land are affected by the supply of available nitrogen. This may be increased through the use of legumes or by supplying nitrogen fertilizers. Observations on the results of work so far have led to two general conclusions: (1) When the supply of nitrogen in the soil is low and the extra inversion and stirring by the plow may increase nitrification, plowing usually gives higher yields; (2) when fertility and moisture conditions are favorable for maximum production, the yields from stubble mulching may be as high as from plowing.

The use of the stubble mulch system has been widely demonstrated to be a most feasible method of reducing wind erosion on cultivated land.

It seems safe to say that this stubble mulch farming is one step that can be inserted in a soil and moisture conservation program. A proper cropping system, terraces and contour farming where needed, along with stubble mulching, will provide the most effective protection against runoff, water and wind erosion that we have. With proper use of fertilizers and legumes, satisfactory yields of crops can be maintained while preserving the soil as a permanent agricultural resource for the future.

SWCRD, ARS, USDA, and U. Nebr., Lincoln, Nebr.

## Tillage

Vomoch, J. A., Fountaine, E. R., and Reginato, R. J. THE INFLUENCE OF SPEED AND DRAWBAR LOAD ON THE COMPACTING EFFECT OF WHEELED TRACTORS. Soil Sci. Soc. Amer. Proc. 22: 178-180. 1958.

Field experiments were conducted on a Yolo fine sandy loam to measure the effect of speed and drawbar load on the compaction caused by the rear wheels of a tractor. Speeds ranging from 1 to 12 miles per hour were compared. Drawbar loading was varied from 0 to 2,000 pounds. Because of its high sensitivity and local importance, infiltration rate was used as the main index of compaction.

Increase in drawbar load and reduction of speed both increased the degree of compaction at each of three moisture contents but the effects were small compared to the changes caused by alterations in the soil moisture content.

Charts and tables.

U. Calif., Berkeley, Calif.

Soehne, W. FUNDAMENTALS OF PRESSURE DISTRIBUTION AND SOIL COMPACTION UNDER TRACTOR TIRES. Agr. Engin. 39: 276-281, 290. 1958.

Based on the formulas of Boussinesq and according to O. K. Froehlich, the pressure distribution in soil was represented in relation to the concentration factor,  $v$ , for different soil conditions. According to Froehlich's formulas, the bulb-shaped curves under different large tires with different loads and under one tire at different soil conditions were calculated. In addition the pressure distributions under different large trailer tires and twin tires with different inflation pressures but the same load were theoretically determined. The pressure in the upper soil layer is determined by the specific pressure at the surface, which depends upon the inflation pressure and the soil deformation, i.e., the size of contact area. The pressure in deeper soil layers is determined by the amount of the load.

Furthermore, the principles of static and kneading soil compaction were shown. According to these principles, the porosity decreases with the logarithm of the applied pressure.

Compaction and plastic flow increase similarly with increasing water content.

Measurements of porosity under tires with different surface pressures showed that soil compaction under rolling tires follows the same basic relation to the pressure in the contact area as soil compaction during static or kneading compaction tests.

Agr. Res. Ctr., Braunschweig-Voelkenrode, Germany.

Andreeva, Y. A. THE INFLUENCE OF VARIOUS METHODS OF DEEPENING THE SURFACE SOIL ON THE AGROCHEMICAL PROPERTIES OF PEAT-PODZOLIC SOILS. Soviet Soil Sci. 4: 380-387. April, 1958.

Results of observations on the nutrient status in the peat-medium podzolic clay-loam soils of the Stepanovkoye State Farm (Moscow region) using various methods of deepening the surface soil are given. The methods are: ordinary plowing to a depth of 8 inches; plowing in some of the podzolic horizon down to 10 inches; soil-improvement plowing to a depth of 16 inches (where the peat horizon is mixed with horizon  $A_2-B_1$  at 3:1); and deep plowing to 24 inches.

The author makes the following conclusions:

1. The deepening of the plow layer in peat-podzolic soil by plowing in some of the podzolic horizon and by soil-improvement plowing does not cause any substantial change in the total adsorbed cations or the soil acidity. Deep plowing causes increases in the upper 8 inches layer of the total adsorbed cations, the acidity, and the content of mobile aluminum, the amount of which decreases only after liming. The soil oxidation-reduction potential decreases as the depth of plowing increases.
2. The amount of nitrate nitrogen accumulating in the 0 to 16 inches horizon of a fallow field as a result of deepening the surface soil decreases systematically with increasing depth of plowing. Nitrification process takes place more actively in the surface horizon as the interval after deep plowing becomes longer, while in the deeper horizons nitrification is inhibited.
3. The amount of available phosphorus (extracted by acetic acid) under wheat crops was greatest with ordinary plowing and least with plowing to 24 inches (deep plowing).
4. The amount of potassium assimilated by plants does not change materially when the plow layer is deepened. The content of exchangeable potassium in the soil increases with an increase in the soil moisture.
5. The highest yields of wheat are obtained with soil-improvement plowing with liming. This is related to the large volume of soil utilized by the plant root system and to better moisture conditions.

Amer. Inst. of Biol. Sci., 2000 P St., N. W., Washington 6, D. C.

Fehrenbacher, J. B., Vavra, J. P., and Lang, A. L. DEEP TILLAGE AND DEEP FERTILIZATION EXPERIMENTS ON A CLAYPAN SOIL. Soil Sci. Soc. Amer. Proc. 22: 553-557. 1958.

A deep tillage and deep fertilization experiment having a split-plot design with depth of mixing of soil and fertilizer as major plots and fertilizer amounts as subplots with four replications was laid out in August 1955 on Weir silt loam, a claypan soil, at the Cooperative Agronomy Research Center at Carbondale, Illinois.

Four depths, 9, 18, 27, and 36 inches, of tillage or mixing and fertilizer placement were used. Four rates of treatment were established, the minimum being 9 tons of limestone, 3,630 pounds of 0-20-0, and 1,452 pounds of 0-0-60 per acre. Rates 2, 3, and 4 were 2, 3, and 4 times rate 1, respectively.

Particle size distribution, bulk density, and 1.2- and 15-atm. moisture determinations on the tilled soil zones indicated that relatively good mixing was obtained. Redistribution of the clay in the soil section by mixing the silty A horizon with the clayey B horizon did not alter the available moisture storage capacity as calculated between 1/3- and 15-atm. moisture percentages.

There were no significant differences in the average moisture content of the soil below a depth of about 24 inches during the 1956 growing season on any of the plots tilled to various depths. The average moisture content of the soil from 0 to 24 inches in depth



was lower in the plots tilled 9 and 18 inches than in the plots tilled 27 and 36 inches, probably because less clay from the B horizon was incorporated in the upper 24 inches of the 9- and 18-inch tilled plots.

Depth of mixing of the soil did not increase corn yields irrespective of rate of fertilizer treatment. For the two years, 1956 and 1957, fertilizer including limestone at the minimum rate increased corn yields an average of 40 bushels per acre over no fertilizer or limestone. There were no significant increases for rates of fertilizer over the minimum rate. In general, the higher rates of fertilizer tended to depress yields, especially where the fertilizer was placed only in the upper 9 inches rather than at greater depths.

Tillage alone did not influence corn root penetration in 1956. Fertilization increased root penetration, especially where the fertilizer was placed throughout the entire tilled zone. Very high rates of fertilizer placed in the upper 9 inches reduced root penetration.

Ill. Agr. Expt. Sta., Urbana, Ill.

Saveson, I. L. and Lund, Z. F. DEEP TILLAGE IMPROVES DELTA "HOT SPOT" AREAS. Crops and Soils pp. 15. February, 1958.

Cotton and other crops have wilted excessively in areas of the Mississippi Delta in the past dry years. Planters refer to the areas as "burn" or "hot spot" areas.

In these areas as soon as hot, dry weather begins the crops become almost stationary in growth and unthrifty for the remainder of the year, in some instances affecting 35 to 40% of the crop. The problem seems to be rather wide-spread in the medium and coarse-textured soils of the area.

Field investigations show a compact soil layer from 5 to 18 inches deep which restricts the downward movement of water and roots, thereby limiting the capacity of soil to supply water and plant nutrients. Soil layers that restrict the downward movement of water and roots are collectively called "pans".

In the Mississippi Delta section the pans in the burn areas are of two types. One is a NATURAL PAN resulting from soil-forming processes. The other is a TRAFFIC PAN resulting from implement traffic and is less restrictive to root development and downward movement of water. Deep-rooted plants and mechanical devices have been used to control pan problems. The latter has been more successful generally.

In Louisiana three deep-tillage methods of shattering the pan were compared to the conventional method for breaking in 1954, 1955 and 1956. The conventional method consisted of disking the field and forming rows with a middle buster and reversing by a second middle buster operation. The row is then prepared for planting by ordering with a disk harrow and drags. One deep tillage method consisted of shattering the soil with subsurface sweeps operated 18 inches deep. The sweeps were set on 40-inch centers to impart a 2 1/2-inch lift to the soil as they moved through it (a modification of subsoiling).

The second deep-tillage method consisted of turning and setting the top 18 inches of soil on edge by deep moldboard plowing. A modification consisted of turning and setting the top 10 inches of soil on edge with one trip of a moldboard plow and then replacing 18 inches deep in the opposite direction with a second trip of the moldboard plow.

In the third method, the top 14 inches of soil was mixed with a series of closely-spaced chisels.

In the two years of moisture stress, 1954 and 1956, the lifted treatment gave the highest increase in yields--an increase of 835 pounds of seed cotton in 1954 and 1,373 pounds of seed cotton in 1956. The edged treatment had an increase of 492 pounds of seed cotton in 1954 and 847 pounds of seed cotton in 1956. The mixed treatment reduced yields in 1954 by 205 pounds of seed cotton, and in 1956 there was practically no increase. A crust formed following this treatment, reducing water intake on these plots.

The test on residual effect of treatments in the following year showed that the edged had a longer residual effect on the increase in crop yields.

Further observations show that for maximum effect the pan must be shattered when the soil is dry. If the work is done when the soil is wet and plastic, the pan will not be shattered and the compaction problem will be made worse.

SWCRD, ARS, USDA, Baton Rouge, La.

Beshore, G. and Redder, N. 7 WAYS TO CUT TILLAGE COSTS. Cappers Farmers pp. 38-39. Feb., 1960.

Although they don't realize it, 99 out of 100 Corn Belt farmers now use some form of minimum tillage.

This article describes the seven methods of tillage that are used by various farmers in the Corn Belt to cut tillage costs.

1. Spring or fall plow, fit lightly, plant.
2. Spring or fall plow--use strip process planting.
3. Fall plow--fit with cultivator just ahead of planter.
4. Deep disk twice (fall and spring or spring only)-- plant.
5. Fall plow--disk lightly and plant in one operation.
6. Spring or fall plow--plant in wheel tracks.
7. Spring plow--plant in one operation.

Cappers Farmers, Topeka, Kansas.

Fullilove, H. M., III, and Reid, J. T. EQUIPMENT FOR PLANTING AND CULTIVATING IN UNPREPARED LAND. Ga. Agr. Expt. Sta., Mimeo. Ser. N. S. 77, 5 pp. 1959.

Equipment for planting and cultivating for stubble-mulch tillage in Georgia is illustrated and described.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

### Fertility Requirements

Seatz, L. F., Sterges, A. J., and Kramer, J. C. ANION EFFECTS ON PLANT GROWTH AND ANION COMPOSITION. Soil Sci. Soc. Amer. Proc. 22: 149-152. 1958.

Two experiments were conducted in the greenhouse to compare the effects of chloride, sulfate, and carbonate salts on the yield and chemical composition of corn and tomato plants on Clarkson sil. Rates of these anions went as high as 25.32-pound-equivalents per 2 million pounds of soil. In the first experiment the chloride series yielded less corn than the other series. A differential moisture regime also resulted in a significant difference in corn yield in favor of the more moist condition. A succeeding crop of tomatoes did not grow properly even though well fertilized with phosphorus. It is postulated that high acidity may be a contributing factor in causing an apparent phosphorus deficiency in tomato plants.

In a second experiment with tomatoes the yield data showed highly significant anion source, phosphorus rate, lime rate, and anion X lime and anion X rate of anion effects. At the highest rate of chloride the yield was less than at the other rates. A highly significant yield increase was found for liming and phosphorus fertilization.

Chemical composition of the plant material reflected the effect of rates of chloride on the percent chlorine in the plant and the rates of sulfate on the percent sulfur. A significant effect of increasing the rate of chloride or sulfate on the phosphorus content of the plants was found.

The authors feel that on the basis of these findings muriate of potash could be used for all the potash fertilization without harmful effects.

Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Fried, M., and Noggle, J. C. MULTIPLE SITE UPTAKE OF INDIVIDUAL CATIONS BY ROOTS AS AFFECTED BY HYDROGEN ION. Plant Physiology 33(2): 139-144. 1958.

The uptake of rubidium, potassium, sodium and strontium by excised barley roots under steady state conditions indicates at least two distinct carrier sites of absorption for each of the cations. One site dominates at higher ion concentrations while the second dominates at lower ion concentrations.

The apparent dissociation constants were determined at each of the two sites for each of the four cations studied. They were similar in magnitude for potassium, rubidium, and strontium and slightly higher for sodium.

Hydrogen ion was shown to compete directly for each of the sites that dominates at lower concentrations of all cations tested. The apparent dissociation constant for hydrogen ion at the strontium, rubidium, and potassium site that dominates at lower concentrations was  $1 \times 10^{-5}$ . The comparable dissociation constant  $K_1$ , at the sodium site was  $2 \times 10^{-6}$ . The apparent dissociation constants for hydrogen were similar in magnitude to the apparent dissociation constants of the ions themselves. Rubidium and potassium were shown to compete for the same site.

SWCRD, ARS, USDA, Beltsville, Md.

Sawhney, B. L., Jackson, M. L., and Corey, R. B. CATION-EXCHANGE CAPACITY DETERMINATION OF SOILS AS INFLUENCED BY THE CATION SPECIES. Soil Sci. 87: 243-247. 1959.

Representative soil montmorillonite samples and some vermiculite-rich soil fractions (associated with illite) from Harpster and Clarence silt loams (K- and  $\text{NH}_4$ -fixing soils), Kilcolgan soil, and a Dutch soil were subjected to cation-exchange capacity measurements. Large fixable cations, such as K, and small nonfixable cations, such as Ca, were used for successive exchange saturation with their subsequent replacement by NaOAc and  $\text{NH}_4\text{OAc}$  leaching solutions and flame photometric determination. With montmorillonite samples, nearly equal cation-exchange capacity values were obtained by either Ca or K saturation with either replacing solution. For fractions containing appreciable vermiculite, however, the cation-exchange capacity values measured with K replaced with  $\text{NH}_4\text{OAc}$  were far less than with small cations such as Ca, used for exchange saturation followed by replacement with  $\text{NH}_4$  or Na. More important still, Ca replaced by NaOAc gave significantly higher values than Ca replaced by  $\text{NH}_4\text{OAc}$ .

These observations show that although any convenient cation theoretically could be used for total cation-exchange capacity determination of materials known to be pure montmorillonite, a general cation-exchange capacity method for soils should involve the use of small cations for both saturation and replacement, since appreciable amounts of vermiculite are often present (often associated with mica or illite) in the sand, silt, or clay fractions of many soils.

U. Wis., Madison, Wis.

Lagerwerff, J. V. COMPARABLE EFFECTS OF ADSORBED AND DISSOLVED CATIONS OF PLANT GROWTH. Soil Sci. 86: 63-69. 1958.

To determine whether adsorbed cations per se affect plant growth, bean plants, their roots mechanically supported by glass beads, were grown under controlled environmental conditions in two types of cultures: (a) solution, and (b) solution plus cation exchange resin (mixed with the beads). The experimental setup was such that for every treatment the composition of the solution phase of each type of culture was identical. This was accomplished by replacing the solution from a common reservoir at 20-minute intervals. The treatments consisted of solutions having various cationic compositions, the resin being equilibrated with the solutions prior to the growth period.

Two series of experiments were carried out. In the first series, the solutions contained  $\text{Na}^+$  and  $\text{Ca}^{++}$  as the only cations. Three sodium-adsorption ratios were established at two electrolyte levels, making a total of six treatments. The treatment period lasted 10 days. In the other series, a complete nutrient solution was used, to which  $\text{Na}^+$  and  $\text{Ca}^{++}$  were added such that three sodium-adsorption ratios were established at a constant electrolyte level. In this case, the treatment period could be extended to 3 weeks.

While growth and Ca uptake decreased, and Na uptake increased as the sodium-adsorption ratio of the solution was increased, no difference in plant response or composition related to the presence or absence of adsorbed sodium or calcium were observed.



These results, which confirm theoretical considerations presented, may be interpreted to the composition of the solution phase of the growth medium fully characterizes the environment of the plant root, the adsorbed cations having no direct effect.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Sowell, W. F., and Rouse, R. D. EFFECT OF Na ON CATION CONTENT OF LEAVES AND BOLL PRODUCTION OF COTTON PLANTS GROWN IN SOLUTION CULTURES IN GROWING CHAMBER. Soil Sci. 86: 70-74 1958.

Na did not affect the leaf content of K, Ca, or Mg at either of the pH or aeration levels of this experiment; however, the K, Ca, and Mg level of the solution greatly affected the Na content of the leaves.

The cotton plant accumulated only small amounts of Na within the leaves when k, Ca, and Mg were supplied in adequate amounts and under good root aeration conditions. When the solution concentration of either K, Ca, or Mg was reduced with the subsequent decrease in leaf content of these ions, Na accumulation within the leaves increased. Poor root aeration decreased leaf accumulation of K, Ca, and Mg, but increased Na accumulation.

There was no difference in cation content of leaves from plants grown at pH 5 compared with pH 6.

Sodium had no effect on boll production at any cation ratio, pH, or root aeration level used in this experiment. A low concentration of K or Ca in the solution and poor root aeration decreased boll production. The lowest level of Mg used in this experiment did not decrease boll production.

Ala. Polytech. Inst., Auburn, Ala.

Scholl, W., Davis, M. M., Fox, E. I., and Woodard, A. W. CONSUMPTION OF COMMERCIAL FERTILIZERS AND PRIMARY PLANT NUTRIENTS IN THE UNITED STATES YEAR ENDED JUNE 30, 1958. U.S.D.A., A.R.S. 41-19-2, 23 pp. 1959.

The consumption of fertilizers and primary plant nutrients (N,  $P_2O_5$ ,  $K_2O$ ) is reported by individual States, the District of Columbia, Hawaii, and Puerto Rico, for the year ended June 30, 1958.

The data were compiled from information furnished by manufacturers on the tonnages of each kind and grade of product shipped to agents, dealers, and consumers in all the areas tabulated except California, Florida, Massachusetts, Missouri, North Carolina, South Carolina, Texas and Virginia. The data for these States were compiled chiefly from the reports of the respective fertilizer-control officials. Supplementary information was supplied by State agencies and fertilizer brokers. Special inquiries were made of all known distributors and custom applicators of anhydrous ammonia and nitrogen solutions.

The quantities of N,  $P_2O_5$ , and  $K_2O$  are based on the average analyses of samples of the products as reported by fertilizer-control officials of the respective State in which they were consumed. The total quantity of fertilizer consumed in the year ended June 30, 1958, was 22,515,763 tons. It comprised 21,576,035 tons of products containing one or more of the primary nutrients and 939,728 tons of secondary and trace nutrient materials. Consumption of fertilizers containing primary nutrients was 189,733 tons (0.9 percent) below that (21,765,768 tons) in 1956-57. The quantity of the secondary and trace nutrient materials was 3,515 tons (0.4 percent) below that (943,243 tons) used in 1956-57.

ARS, USDA, Inform. Div., Washington 25, D. C.

Brown, D. A., and Place, G. A. THE RELATION BETWEEN SOIL MOISTURE AND EFFICIENCY OF FERTILIZER USAGE. Ark. Farm Res. 8(5): 10. 1959.

In order to define more clearly the effects of soil moisture on plant growth, a greenhouse study was carried out with soybeans. Three soils from the Delta area of Arkansas were selected--Dundee sil, Beulah l, and Sharkey c. The first two soils gave similar results and therefore only the results on Dundee sil and Sharkey c are presented. Fertilizer and lime, tagged with appropriate radioisotopes, were applied at rates of 50, 50, and 1,000 pounds per acre of potassium, phosphorus, and calcium, respectively.

Eight soil moisture levels, ranging from an almost air-dry soil to saturation were established in each of the soils. Soybeans were grown at each moisture level and the amount of each nutrient element taken up at the respective level was determined by counting the radioactivity of the plant material.

The data presented in the table indicate the tremendous influence soil moisture has on plant growth and nutrient uptake. The available moisture range is defined here as the moisture range from field capacity to wilting percentage.

It is evident from these data that as the soil loses moisture in going from field capacity to wilting percentage the effect is to reduce the absorption of calcium, phosphorus, and potassium. As the soil moisture dropped to as low as 25 percent the absorption of calcium, potassium, and phosphorus were reduced by as much as 53, 64, and 31 percent for plants grown in the Dundee soil and 7, 59, and 35 percent, respectively, for those growing in the Sharkey soil.

Plants growing in the Dundee soil at near the wilting percentage absorbed 94 percent less calcium, 87 percent less potassium and 81 percent less phosphorus. For plants growing in the Sharkey soil the absorption was 48 percent less calcium, 63 percent less potassium, and 43 percent less phosphorus.

The relationships shown by these data indicate that for the most efficient absorption of nutrient elements, the soil moisture level should be maintained at or slightly above 50 percent available moisture for plants growing in Dundee soil. The maintenance of a higher level of moisture (75 percent) in the Sharkey soil might prove beneficial.

It is also evident, from these relationships, that nutrient uptake during prolonged dry periods can be reduced and the use of supplemental irrigation to maintain adequate soil moisture could result in a much greater efficiency from applied fertilizer materials. Thus, the increased efficiency of utilization of applied fertilizer materials through the maintenance of adequate soil moisture represents an additional advantage in favor of including irrigation as a basic part of the farm operation.

Effect of Soil Moisture on Absorption of Nutrients by Soybeans

Soil type and nutrient	Available soil moisture level				
	100%	75%	50%	25%	0%
Percent decrease in nutrient uptake <sup>1</sup>					
Dundee silt loam					
Calcium	0	14	25	53	94
Potassium	0	5	2	64	87
Phosphorus	0	0	11	31	81
Sharkey clay					
Calcium	0	1	2	7	48
Potassium	0	59	59	59	63
Phosphorus	0	32	34	35	43

<sup>1</sup> The percentage decrease is based on the amount of uptake at the 100% available moisture level (field capacity).

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Pratt, P. F., Harding, R. B., Jones, W. W., and Chapman, H. D. CHEMICAL CHANGES IN AN IRRIGATED SOIL DURING 28 YEARS OF DIFFERENTIAL FERTILIZATION. *Hilgardia* 28: 381-420. 1959.

One of the most extensive long-term fertility trials on irrigated soils in a semiarid region is the fertilizer experiment with citrus being conducted at Riverside.

Some chemical changes that have occurred during thirty-eight years of irrigation and growth of citrus, and twenty-eight years of differential fertilization of a Ramona sandy loam have been reported and discussed. The following paragraphs summarize the results.

**Acidity and Alkalinity.** Irrigation water increased the alkalinity of the soil. The effect of fertilizers varied from extreme acidification with high rates of  $(\text{NH}_4)_2\text{SO}_4$  to extreme alkalization with  $\text{NaNO}_3$ .

**Lime Accumulation.** Lime content increased except where  $(\text{NH}_4)_2\text{SO}_4$  acidified the soil. The accumulation was greatest in the 0 to 6- and 24 to 36-inch depths with a minimum at the 6 to 12-inch depth.

**Salinity.** There was a small increase in salinity from irrigation water alone. Treatment with  $(\text{NH}_4)_2\text{SO}_4$  or with  $\text{NaNO}_3$  produced high salinity. The yield of navel orange fruits was negatively correlated with the conductivity of the saturation extract.

**Organic Carbon.** Treatment with manure increased the organic C in the 0 to 6-inch depth but had no effect at other depths. Other treatments had only small effects.

**Phosphorus.** Acidifying treatments increased the soluble P. More than 60 percent of the P added as triple superphosphate accumulated in the surface 6 inches, and greater than 80 percent was retained in the 0 to 12-inch depth.

**Cation-Exchange Capacity and Exchangeable Cations.** The cation-exchange capacity was positively correlated with organic C in the soil. About half or more of the cation-exchange capacity of the surface soil was associated with organic matter. Where the soil became acid the exchange acidity displaced mainly Ca. Where exchangeable Na increased there was a corresponding decrease in exchangeable Ca. Exchangeable Mg was depleted in proportion to the amounts of salts added as fertilizers and soil amendments.

**Potassium.** Potassium fixation was mainly in the soil below the 12-inch depth. The percent of the applied K that was fixed into nonexchangeable forms increased with increase in rate of K application.

**Soluble Copper and Zinc.** The soluble Zn was low in extremely acid soil and soil treated with lime, and was highest at pH values near 6.5 where no lime was added. Soluble Cu was lowest where lime was added but pH, per se, had no effect. Soluble Cu decreased with increase in organic C.

Calif. Agr. Expt. Sta., U. Calif., Berkeley, Calif.

Birch, H. H. SOIL DRYING AND SOIL FERTILITY. Tropical Agriculture 37: 3-10. 1960.

A brief review of the literature is given which illustrates the beneficial effects of soil drying on soil fertility. While drying increases the availability of several elements, soil nitrogen appears to be most largely and consistently affected. Improved physical conditions following drying may be also involved.

Recent work on the effect on humus decomposition and nitrification is discussed. The effect of soil drying on the amount of mineral nitrogen produced on moistening is largely a function of the humus content of the soil and the logarithm of the time the soil is in an air-dry state prior to moistening. The amount of mineral nitrogen produced in this way are sufficiently large, even with soil poor in humus, to exert a considerable influence on soil fertility. A possible explanation for the drying effect is given and this hypothesis, together with the recorded observations is applied to various aspects of agriculture such as nitrogen fertilization trials, irrigation and the rundown of soil fertility.

East African Agr. and Forestry Res. Organ., Kikuyu, Kenya.

Lunt, H. A. DIGESTED SEWAGE SLUDGE FOR SOIL IMPROVEMENT. Conn. Agr. Expt. Sta. B. 622, 30 pp. 1959.

Connecticut Sewage treatment plants produce more than 30,000 tons of digested sludge annually, and the amount is increasing with the growth of our cities and larger towns. Most of this vast quantity of sludge is either dumped or incinerated.

Analysis of digested sludges shows about 50 percent organic matter, plus considerable available plant food. Except for potash, digested sludge compares rather favorably with farm manure, both in analysis and in demonstrated usefulness.



Experiments were initiated in 1949 to explore the suitability of digested sewage for soil improvement and as a fertilizer. The work was done in greenhouse pots, outdoor soil frames, and field plots.

The authors conclude that, on the basis of the results obtained in these experiments, digested sewage sludge as produced in Connecticut treatment plants improves the physical condition of the soil and has a more lasting effect than does manure.

It also supplies nitrogen and some phosphorus and trace elements. When used under proper conditions sludge improves current crop yields. High applications may delay seed germination, but they seldom lessen the final germination count.

Because the various sludges differ in reaction and in composition, it is important to know the nature of the sludge to be used. The acid sludges, especially those from sewage containing industrial wastes, may have severe adverse effects on plants. Usually such toxicity, which is due to copper or zinc, or both, and probably to iron deficiency induced by these metals, can be avoided by liming the soil to pH 6.0 or higher. Applications of sludge as high as 150 to 250 cu. yds. per acre can be used under some conditions, especially for such crops as grains and grasses even on acid soils. However, 50 cu. yds. is a safer rate.

Where the crop requires a fairly to strongly acid soil, the application of sludges for soil improvement must be made with caution, if at all. This is particularly true where the response of the crop to relatively high concentrations of copper and zinc is unknown. Light applications, i. e., 15 to 20 cu. yds. per acre, may be permissible.

The Connecticut State Department of Health does not advocate the use of fresh digested sludge on crops that are to be eaten raw. If the sludge is applied and worked into the soil six months or so prior to seeding such a crop, no health hazard is involved.

Conn. Agr. Expt. Sta., New Haven, Conn.

Hinkle, D. A., and Jacks, J. F. COTTON FERTILIZER TRIALS ON BLACKLAND SOILS. Ark. Agr. Expt. Sta. B. 613, 10 pp. 1959.

This report includes data from three years of fertilizer experiments on cotton grown on Sharkey clay soil at Marie, Arkansas, during the years 1954 to 1956.

Soil tests revealed the soil to be low in nitrogen and high in phosphorus and potassium. Previous experiments on this soil type had indicated doubtful response from phosphorus and potassium.

The study involved five rates of nitrogen--0, 40, 80, 120, and 240 pounds per acre--applied in two different ways. Ammonium nitrate was the source of nitrogen used. Two of the treatments provided a comparison of 40 pounds of nitrogen from ammonium phosphate sulfate (16-20-0) with the same amount of nitrogen from ammonium nitrate.

The results indicated no consistent response from phosphorus on this soil type. Nitrogen did consistently increase cotton yields in all years, even in the extremely dry year of 1954. The first 40 pounds of nitrogen increased yields by 350 pounds of seed cotton, the next 40-pound increment further increased yields 125 pounds, and the third 40-pound increment gave an additional 100 pounds increase. Rates higher than 120 pounds did not appreciably increase yields; therefore the 120 pound rate is about the maximum amount that would be expected to increase yields. Whether a farmer would want to use this maximum rate or some rate less than maximum will depend on economic factors.

The convention method of application, in which the ammonium nitrate was applied in water furrows and bedded upon before planting, was as satisfactory as applying all the nitrogen in the beds.

Nitrogen increased the amount of cotton picked at the first picking; thus it contributes to earliness of cotton grown in this soil type.

Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

Young, V. H., Fulton, N. D., and Waddle, B. A. FACTORS AFFECTING THE INCIDENCE AND SEVERITY OF VERTICILLIUM WILT DISEASE OF COTTON. Ark. Expt. Sta. B. 612, 26 pp. 1959.

Verticillium wilt disease may affect a relatively large number of plants without seriously reducing cotton yields.

July and August, when much of the vegetative growth and fruiting of cotton take place, appear to be the critical period when unfavorable weather conditions may promote serious damage from the Verticillium wilt pathogen. The data indicate that temperatures below 80° F., especially with high rainfall, during the critical months of July and August are necessary for severe outbreaks of the disease.

Studies of various methods of weed control by scraping, use of herbicides, and normal, shallow, and deep plowing of cotton indicated that significant reduction in the incidence of wilt and significant yield increases resulted when the most shallow cultivation compatible with weed control was practiced.

Higher than normal planting beds for cotton failed to give significant increases in soil temperature under Mississippi Delta conditions and did not significantly affect either wilt incidence or cotton yields. Root injury due to poor drainage during periods of heavy rainfall may favor more severe attacks of the disease and improved drainage might prove beneficial for Verticillium wilt control.

In the experimental plots at Osceola, the type of fertilization, particularly with respect to the level of nitrogen, had a profound effect on the incidence of Verticillium wilt and on yields of seed cotton.

In the three-year period 1951 to 1953 the treatments that contained no nitrogen showed about half the incidence of wilt that was found in the most seriously affected plots but yields were about two-thirds of those in the highest yielding plots.

Mixed fertilizers of 6-8-12 grade when applied at a rate of 600 pounds per acre gave yield increases of approximately 500 pounds of seed cotton per acre with slight but generally not statistically significant increases in the incidence of wilt.

Applications of straight nitrogenous fertilizers in moderately high amounts (480 pounds Cyanamid, 600 pounds sodium nitrate, and 300 pounds ammonium nitrate) were in the top eight treatments from the point of view of yields, and likewise were in the eight with the highest wilt incidence. High yields were definitely associated with high incidence of wilt in this group. In the period 1951 to 1953 yields from the plots receiving 600 pounds of ammonium nitrate were well below those of the group just mentioned, and throughout the four years of the study these plots showed the highest wilt incidence. Less than 300 pounds of ammonium nitrate gave only moderately high yield increases and relatively low wilt incidence.

The addition of other materials--hydrated lime, copper sulfate, Es-Min-El, and elemental sulfur--to 600 pounds of 6-8-12 mixture had little or not significant effect on either wilt incidence or yield of seed cotton, with the exception of sulfur. The use of sulfur at the rate of 2,000 pounds together with 600 pounds of 6-8-12 fertilizer per acre decreased yields over the whole period of the study with apparent toxic effects on the plants. Increasing the amount of 6-8-12 fertilizer from 600 to 900 pounds per acre with no supplemental material added gave highly significant yield increases accompanied by statistically significant increases in wilt incidence.

Ammonios-phos used at the rate of 340 pounds per acre gave the highest average annual yield throughout the four years. These high yields were accompanied by moderate increases in wilt incidence.

One hundred pounds of ammonium nitrate plus alfalfa meal at the rate of 2,000 pounds per acre gave highly significant yield increases in three out of four years. From the viewpoint of wilt incidence this treatment ranked well below the straight high nitrogen applications. There was no evidence that the organic matter provided by this amount of alfalfa meal or by stable manure was favorable for the development of severe wilt outbreaks.

Ark. Expt. Sta., U. Ark., Fayetteville, Ark.

Carlson, C. W., and Grunes, D. L. EFFECT OF FERTILIZATION ON YIELDS AND NUTRIENT CONTENT OF BARLEY. Soil. Sci. Soc. Amer. Proc. 22: 140-145. 1958.

The fertility status of the  $A_{1p}$ , AC, and  $C_1$  horizons, and of mixtures of horizons  $A_{1p}$  and  $C_1$ , of a Gardena loam was evaluated in a controlled light-temperature plant-growth chamber. Barley growth was greatest on the  $A_{1p}$  horizon at all fertilizer levels. Applications of nitrogen fertilizer increased yields on all horizons, but phosphorus additions did not. When both N and P were added, yields were greater on all horizons than

when either was added alone. Fertilization with minor elements increased yields on the AC horizon while potassium sulfate increased yields on the C<sub>1</sub> horizon. In mixtures of horizons A<sub>1p</sub> and C<sub>1</sub>, and at all N and P rates, yields increased as the percentage A<sub>1p</sub> increased. Total nitrogen in plant tops grown on horizons AC and C<sub>1</sub> was similar, but less than that in plant tops grown on the A<sub>1p</sub> horizon.

Total phosphorus absorbed was less for plants grown on the C<sub>1</sub> horizon than for plants grown on the A<sub>1p</sub> horizon. In the presence of added nitrogen, amounts of total phosphorus absorbed from the AC horizon were similar to amounts absorbed from the C<sub>1</sub> horizon at the lower P rates, and from the A<sub>1p</sub> horizon at the high P rate.

Yield increases observed on the nitrogen treatments, with increasing percentage of the A<sub>1p</sub> horizon in the mixtures, were due in large part to the greater phosphorus availability of the A<sub>1p</sub> horizon. There was a tendency for the addition of C<sub>1</sub> soil to decrease the availability of fertilizer phosphorus to plants.

SWCRD, ARS, USDA, Mandan, N. Dakota

de Roo, H. C. FERTILIZING CONNECTICUT TOBACCO. Conn. Agr. Expt. Sta. B. 613, 37 pp. 1958.

The advent of synthetic binder has revolutionized the production of stalkcut tobacco in the Connecticut Valley. Increasing production costs and disappearing premium for certain qualities of high grade binder type tobacco compel a re-examination of fertilization practices as a means of lowering the cost of production.

The choice of a nitrogen fertilizer, like the method and time of application, first of all turns on the problem of leaching in sandy soils.

Use of organic sources, such as meals and manures, insures against losses by leaching during the critical first 4 to 6 weeks of low nitrogen absorption by the crop, a time of leaching rains. Oil seed meals are low in total availability and are expensive.

Synthetic organic and inorganic nitrogen materials are suitable fertilizers for tobacco when used in accordance with their peculiar properties. They are best applied in part at planting time and then supplemented by side dressing with nitrates just prior to the time of maximum absorption by the crop. These materials are relatively cheap and their use should also result in savings in handling and application costs. High-analysis fertilizers applied during tillage, planting, and cultivation should give some significant savings.

Farm manures can provide an economical and suitable source of organic nitrogen. Cheap inorganic forms of nitrogen can be converted into organic form by fertilizing cover crops. Plowing under considerable amounts of organic matters maintains the organic fertility level of the soil and renders soils less susceptible to compaction and crusting.

Higher yields can be produced by higher applications of nitrogen, but the quality may be lowered.

Improved methods of fertilizer placement and supplemental applications are means of economizing in fertilization. Placement methods markedly affect the recovery of the nutrients applied; band placement is especially effective in reducing phosphate fixation.

The choice of phosphate and potash fertilizers offers no particular problems, except that extremely large applications of sulfur with these materials should be avoided.

Conn. Agr. Expt. Sta., New Haven, Conn.

Olsen, K. L. MINERAL DEFICIENCY SYMPTOMS IN RICE. Ark. Expt. Sta. B. 605, 11 pp. 1958.

A key to the mineral deficiency symptoms in Zenith rice follows.

Deficient mineral

I. Foliar discoloration appearing first on older leaves

A. General effect over entire plant

a. Plants more erect than usual and light green; lower

leaves become yellow, brown, and dry starting at the tip

Nitrogen



- b. Plants more erect than usual and dark green; after an extended period the lower leaves become orange-brown, roll up, and dry starting at the tip
- B. Effect localized on lower leaves
  - a. Rust-colored mottling first at tip and along edges of leaf blade; leaf edges dry giving a marginal scorched appearance
  - b. Grey-black discoloration at tip and along edges of leaf blade; yellow streaks develop along leaf edges; entire leaf lighter green
- II. Foliar discoloration appearing first on the youngest leaf
  - A. Terminal bud dies with severe deficiency
    - a. A yellow to white diffuse pattern appears about one-third of the way back from the leaf tip; the next leaf formed will have a greater chlorotic area with this portion of the leaf blade remaining rolled
  - B. Terminal bud does not die
    - a. Yellow coloration appearing between the veins of the youngest leaf; increased severity causes a general chlorosis becoming more colorless nearer the base of the leaf blade

Phosphorus

Potassium

Magnesium

Calcium

Iron

Typical foliar symptoms, due to deficiencies of nitrogen, phosphorus, potassium, calcium, magnesium, and iron, developed on rice plants grown in nutrient solutions lacking each respective element. Tillering of plants was greatly restricted by a deficiency of nitrogen and to a lesser extent by the lack of the other elements except calcium. Root and top development were restricted very significantly by deficiencies of each of the elements, but particularly by the lack of potassium and nitrogen.

ARS, USDA and Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

Hunter, A. S., Gerard, C. J., Waddoups, H. M., Hall, W. E., Cushman, H. E., and Alban, L. A. WHEAT FERTILIZATION EXPERIMENTS IN THE COLUMBIA BASIN 1953-55. Oreg. Agr. Expt. Sta., C. of Inform. 570, 24 pp. 1959.

The effect of fertilizers on yields of wheat in 98 cooperative experiments on farms in many parts of the Columbia Basin summer fallow wheat area of Oregon during 1953-54 and 1954-55 are presented in detail. Effects on test weights and protein contents are also discussed.

Soil type, soil depth, available moisture, and past management differ from farm to farm and from area to area. Also, variations in climatic conditions from year to year and from place to place make it impractical to base general fertilizer recommendations on data from 2 years' work.

Numerous Charts and Graphs.

Agr. Expt. Sta., Oreg. State Col., Corvallis, Oreg.

Schuylenborgh, J., von, and Sarjada, R. M. ON THE FERTILIZATION OF SUGAR CANE. Netherlands U. Agr. Sci. 6: 256-266. 1958.

Soil and leaf analyses, combined with field experiments, indicate that the fertilization of sugar cane in Indonesia is in many cases inadequate.

It was calculated that a sugar cane crop removes an average of 100 kg N, 100 kg  $PO_4$ , 350 kg K, 30 kg Ca and 30 kg M per annum per ha (112 lbs. N, 75 lbs.  $P_2O_5$ , 471 lbs.  $K_2O$ , 34 lbs. Ca and 34 lbs. Mg. per acre) from the soil whereas the annual supply of the area under investigation was: 110-114 kg N, 100 kg  $PO_4$ , 6 kg K, 55 kg Ca, 7 kg Mg and 15 kg Na per ha.

It is demonstrated that the rendement (% sugar of cane weight) value depends on the uptake and consequently the content of N, P, and K in the cane crop. Since the uptake of the K is greatly affected by the uptake of Mg and Ca, it is evident that the problem of sugar production is very complex.

The rendement level is determined by the concentration ratios of the elements in particular, and not by the absolute content in the leaf. When the N content in the leaf is sufficiently high, a relationship exists between the rendement and the K/PO<sub>4</sub> ratio in the leaf; there will be an optimum value for the ratio. If the N content and the PO<sub>4</sub> content are adequate, a direct relationship can be noticed between the yield and the K content of the leaf; there will likewise be a correlation between the K/PO<sub>4</sub>+N, K/PO<sub>4</sub> and K/N ratios and the rendement. When the K content of the leaf is adequate, there will be a relationship between the rendement and the PO<sub>4</sub>/N ratio in the leaf; the optimum value is approximately 0.215.

From the results, it can be concluded that the nitrogen has the greatest effect on cane production. On the other hand it tends to decrease the sugar content. In order to combine high cane yield with high sugar yields, great attention should be paid to P and K fertilization.

The results obtained from leaf analyses of sugar cane crop grown on simply designed experimental fields make it possible to give advice on what is the most adequate fertilization.

This investigation proves once again that fertilization experiments can only give definite results when they are combined with leaf analysis. It is also evident that the mineral composition of the crop is a better guide to the fertility level of the soil than soil analysis.

Koo, R. C. J., Reitz, H. J., and Sites, J. W. A SURVEY OF THE MINERAL NUTRITION STATUS OF VALENCIA ORANGE IN FLORIDA. Fla. Agr. Expt. Sta. B. 604, 59 pp. 1958.

A survey of 168 commercial Valencia orange groves from the major citrus producing areas of Florida was undertaken in 1955. The object of the survey was to study the mineral nutrition status of the groves in relation to fruit production and quality by means of foliage, fruit, and soil analyses.

All the trees were budded on rough lemon rootstock between the ages of 14 and 47 years, with more than 85 percent of the trees between the ages of 16 and 35 years. By far the majority of the groves (80 percent) were situated on soils of Lakeland series. The number of trees planted to an acre ranged from 45 to 116, with 85 percent of the groves having between 48 and 73 trees per acre.

Fruit production over a period of three years averaged 6.14 boxes per tree, covering a range from 2.45 to 10.48 boxes; or 400 boxes per acre, with a range from 166 to 734 boxes.

In general, most of the groves were adequately fertilized, although both types and rates of material varied widely. Nitrogen was the only nutrient element under study that that could be directly related to fruit production, while phosphorus, potassium, and magnesium, in the amounts used, did not appear to be related to variations in fruit production. Correlations were found between the nitrogen content of leaf and the nitrogen applied in the fertilizer. Phosphorus application was related to phosphorus content of fruit and the available phosphorus in soil. Potassium, when considered together with nitrogen, was significantly correlated to the potassium content of leaf and fruit. The fact that the water-soluble magnesium applied in the fertilizer was not related to the magnesium content of leaf and fruit or the extractable magnesium content of soil would suggest that it was not the only source of magnesium. Evidence suggests that dolomite is an important source of magnesium. The use of minor elements by most of the growers corresponded closely to recommendations.

Over 80 percent of the groves had a soil reaction ranging between pH 5.4 and 6.2, which is generally accepted as satisfactory for growing citrus on acid sandy soil. Both the extractable calcium and magnesium contents of the soil varied directly with the soil reaction, whether dolomite or calcium limestone was used as the amendment. Soil reaction seemed to affect the magnesium content of leaf and fruit more than other elements. Highest magnesium content was found in the proximity of pH 5.9.

The groves were well distributed among the different ranges of soil copper content. The influence of soil copper on fruit quality was of no practical importance. The available phosphorus content of soil varied directly with copper. Potassium and magnesium contents in leaf and fruit were affected by soil copper content.

Fruit quality was more closely related to the mineral composition of fruit than that of the leaf. It seems desirable to set up standards of fruit composition for control of fruit quality, in view of the poor correlation between fruit quality and mineral elements used in the fertilizer.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Seatz, L. F., Gilmore, T. R., and Sterges, A. J. EFFECTS OF POTASSIUM, MAGNESIUM, AND MICRONUTRIENT FERTILIZATION ON SNAP BEAN YIELDS AND PLANT COMPOSITION. Soil. Sci. Soc. Amer. Proc. 22: 137-140. 1958.

Snap beans were fertilized with 4 levels of Mg at each of 2 levels of K, and with Mn, Cu, Zn, and a micronutrient mixture at a single K level. On Hartsells fsl that is very low in native fertility. Bean yields were not affected by any of the treatments.

Top leaves, bottom leaves, and leaf petioles were taken for chemical analysis when the beans were in the early bloom stage of growth. Mg content of the bottom leaves was higher than that of the top leaves and petioles. Mg content increased with Mg applied and was higher at low K than at the high K level. Ca was also higher in the bottom leaves than in the top leaves or petioles. K content was higher in petioles than in leaves, and was higher at high K than at the low K level. No Mg effect was apparent.

Mg content of petioles increased regularly with Zn < Mn < Cu < Mixture treatments. Zn, Mn, and Cu increased the Ca content of the bottom leaves. Zn reduced the K content of the bottom leaves.

Bottom leaves contained a higher content of cations followed by petioles and top leaves.

Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Bradley, G. A., and Fleming, J. W. FERTILIZATION AND FOLIAR ANALYSIS STUDIES ON WATERMELONS. Ark. Agr. Expt. Sta. B. 610, 31 pp. 1959.

Fertilizer tests with watermelons were conducted on Norfolk fs in Hempstead County, Arkansas during 1956, 1957, and 1958.

The effects of various combinations of nitrogen, phosphorus, and potassium were measured with respect to number, size, and total yields of marketable melons; sugar content; and foliar percentages of phosphorus, potassium, calcium, and magnesium. A preliminary evaluation is made of foliar phosphorus and potassium as guides to the nutrient status of watermelons.

It appeared that 60 pounds of nitrogen per acre as 30 pounds under the row and 30 pounds sidedressing was adequate for good yields.

Sixty pounds of phosphorus per acre also seemed to assure good yields.

Thirty to 60 pounds per acre was an adequate potassium application, the indication being that in years of high rainfall, the higher application would be better.

The major effect of fertilizers was upon number of marketable melons produced, with a minor effect upon fruit size.

A shortage of any of the major elements tended to result in a slight reduction in sugar content. When yields were not affected by fertilizer differences, sugar content was not affected. Thus, providing adequate fertilizer for good yields assures good quality.

Applications of nitrogen, phosphorus, and potassium had many and varied effects on foliar content of phosphorus, potassium, calcium, and magnesium. Reasons for such effects are discussed.

Foliar analysis of old leaves for evaluating plant nutrition with respect to phosphorus and potassium is discussed with reference to complicating factors in interpretation. A method for arriving at critical percentages of phosphorus and potassium is presented. Using this method and eliminating complicating factors as much as possible, a high rate of predictive accuracy was possible.

Ark. Agr. Expt. Sta., Fayetteville, Ark.



Recent interest in growing sweet potatoes in the Delta has spotlighted the need for fertilizer work on soils of the area. Previous fertilizer studies on sweet potatoes have been restricted largely to upland soils. In the Coastal Plain region, sweet potatoes have not required large additions of nitrogen, phosphorus, or potassium despite the relatively low soil levels of these elements.

It has been estimated that a 300-bushel crop of sweet potatoes would contain, in the roots and vines, approximately 75 pounds of nitrogen, 20 pounds of phosphate, and 120 pounds of potash. In fertilizer trials of Coastal Plain soils response has not been obtained to more than 25 pounds nitrogen, 50 pounds phosphate, or 25 pounds potash, even in cases where yields have been 500 bushels or more per acre. The sweet potato, which develops a deep root system when grown on well drained soil, qualifies as one of the most efficient vegetable crops in obtaining nutrients from the soil.

Sweet potato fertilizer trials were conducted in 1956 and 1957 on Delta soils in Chicot County. In both seasons, soil test results showed the sandy loam soil to be low in organic matter, high in phosphorus, and high in potassium. Sweet potatoes followed a well fertilized cotton crop in both seasons. Rainfall was light in the winter and spring preceding the 1956 crop while rainfall was exceptionally heavy preceding the 1957 crop.

Good yields were obtained from all the fertilizer treatments in 1956 with no significant yield differences between treatments.

The story was somewhat different in 1957, probably as a result of the heavy winter and spring rainfall. In this season, the best yields were obtained when a complete fertilizer mixture was used. Significant yield increases resulted from the addition of potash alone, or nitrogen alone, but adding the two elements together resulted in no increase over the use of either alone. However, the addition of phosphorus along with nitrogen and potash increased the yield considerably. The use of higher rates of nitrogen, phosphorus, and potassium, as in the 40-80-80 treatment, increased yields further but not significantly.

These trials point out the need for considering weather and management factors along with soil test results in making fertilizer recommendations. On transplanted crops such as sweet potatoes, a small application of complete fertilizer is recommended when previous rainfall has been heavy, even though soil phosphorus and potassium may be high.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Klechkovskii, V. M., and Gulyakin, I. V. THE BEHAVIOR IN SOILS AND PLANTS OF TRACES OF STRONTIUM, CESIUM, RUTHENIUM AND ZIRCONIUM. Soviet Soil Sci. 3: 219-230. March, 1958.

The processes of sorption and desorption in soils and the uptake by plants and distribution in them of traces of cesium, ruthenium, and zirconium were investigated in experiments using radioactive isotopes of these elements.

When plants are grown in water culture, they take up cesium and strontium at a higher rate and ruthenium and zirconium at a considerably lower rate. In this process the ruthenium and zirconium are retained preponderantly in the root system, while strontium and cesium pass to the above-ground organs, accumulating principally in the vegetative organs with relatively small quantities in the reproductive organs.

Investigations of the distribution of traces of the same elements when introduced into the plant through the leaves showed that cesium had the best ability to translocate from the treated leaves into other parts of the plant and to accumulate in the reproductive organs.

The processes of sorption and desorption of cesium and strontium in soils affected the uptake from the soil of radioactive isotopes of these elements by plants.

Although, in a water culture, cesium-137 and strontium-90 are members of the group of fission products taken up most rapidly by plants (as distinguished from elements such as zirconium and ruthenium which are taken up in relatively small quantities into the above-ground organs of plants), when a comparison is made of the uptake by plants of traces of the same elements from the soil, cesium is transferred to the group of relatively immobile elements, traces of which are taken up by plants from the soil in considerably smaller quantities than are traces of strontium.

Traces of strontium and cesium are sorbed by soils, in general, by ionic-exchange adsorption. However, while strontium retains practically all of its capacity to be displaced into the solution by reaction with neutral salts, traces of cesium are more tenaciously retained in the adsorbed state and so are not fully displaced into the solution by a neutral salt. Evidently some part of the traces of cesium adsorbed by the soil is fixed in non-exchangeable form, which may be one of the causes for the considerably smaller quantity of it taken up by plants from the soil as compared to the uptake of it from a water medium.

Traces of ruthenium are, as a rule, adsorbed at a lower rate by soils than are traces of strontium, cesium and zirconium, but, once having been sorbed by the soil, ruthenium, like zirconium, is not displaced from the adsorbed state by neutral salts. However, the importance of the soil sorption process is shown to a lesser degree on the uptake of ruthenium and zirconium by plants than it is on that of cesium, since in water culture ruthenium and zirconium are distinguished by their low ability to translocate from the root system into the organs above-ground.

The fact that strontium is adsorbed by soils by means of ionic exchange and that it is easily desorbed account for the possibility of the relatively high rate of uptake of radioactive strontium from the soil into the plant. Applying fertilizers to the soil and liming acid soil both affect the uptake of strontium and cesium by plants. Liming strongly decreases the uptake of strontium. The application of potassium fertilizer decreases the uptake of cesium.

In the processes of sorption and desorption in soils of radioactive elements representing two genetically related radioactive nuclides (such as strontium-90 and yttrium-90), there is a disturbance of the equilibrium ratio between the mother and daughter isotopes. This disturbance of the equilibrium ratio between the mother strontium-90 and the daughter yttrium-90 is also observed when they are taken up by plants, and particularly seen when they are translocated from one organ of a plant to another. With foliar application of strontium-90 the daughter nuclide yttrium-90, formed in the leaf tissue, is translocated to young, growing tissue faster than the mother nuclide strontium. A similar phenomenon is confirmed in experiments with grafted plants where observations were made on translocation of  $\text{Sr}^{90} + \text{Y}^{90}$  when traces of radiostrontium were introduced before grafting through the roots of one component of the grafted plant.

Amer. Inst. of Biol. Sci., 2000 P. St., N. W., Washington 6, D. C.

Schulz, R. K., Moberg, J. P., and Overstreet, R. SOME EXPERIMENTS ON THE DECONTAMINATION OF SOILS CONTAINING STRONTIUM 90. *Hilgardia* 28: 457-475. May, 1959.

The possibility that large areas of the landscape could become contaminated with strontium 90 through fallout or reactor accidents has necessitated studies of means of decontaminating soils containing radio-strontium. In this work three possible methods were investigated: (1) displacement by electrolytes and leaching; (2) physical immobilization using asphalt preparations; and (3) placement at depth.

Of the various electrolytes used, ferric chloride and hydrochloric acid were most effective. The use of the electrolytes followed by leaching with 5 feet of irrigation water displaced up to 90 percent of the Sr 90 below the surface 6 inches. This, however, was not sufficient decontamination so that the land could be put back into agricultural use. In addition the procedure is very expensive.

By spraying the soil surface with asphalt, it was found that 97 percent of the Sr 90 could be removed by peeling off the hardened crust. When the crust was cultivated into the soil profile, however the Sr 90 gradually became available to plants.

In order to investigate the possibility of reducing the uptake of Sr 90 by deep plowing, experiments were conducted in lysimeters in which the isotope was placed in bands at different depths in the soil. When the soil was cropped to barley, a marked reduction of uptake of Sr 90 with depth of placement was observed. In irrigated barley the content of strontium 90 per gram of plant material was reduced tenfold when the depth of placement was increased from 2 inches to 2 feet.

Calif. Agr. Expt. Sta., U. Calif., Berkeley, Calif.



Romney, E. M., Alexander, G. V., Rhoads, W. A., and Larson, K. H. INFLUENCE OF CALCIUM ON PLANT UPTAKE OF SR 90 AND STABLE STRONTIUM. Soil Sci. 87: 160-165, 1959.

Crop plants accumulate radiostrontium, a product of nuclear fission, from soils contaminated with fallout from atomic explosions or waste products from nuclear reactors. The attention of agriculturalists has been focused on the possibility of hazards arising from radiostrontium contamination because of the similarity of Sr to Ca in soil, plant, and animal systems, and the relatively high fission yield of the long-lived Sr 90 isotope. In considering means of reducing crop uptake of radiostrontium, the application of calcareous fertilizer amendments to contaminated soil appeared to be the most hopeful and practical treatment. The purpose of this investigation was to study the influence of applied Ca on plant uptake of Sr 90 from nutrient solutions independent of soil factors and from widely different types of agricultural soils.

Additions of Ca reduced Sr 90 and Sr uptake by beans from nutrient solutions. Added  $\text{CaCO}_3$  and  $\text{CaSO}_4$  reduced Sr 90 and Sr uptake from an acidic, Sassafras sandy loam that was low in native Ca supply. Levels normally applied to this type of soil under good management (2 to 5 tons an acre) were most effective. The inhibiting influence of Ca on Sr 90 uptake persisted in Ladino clover over prolonged cropping periods. Neither form of applied Ca reduced Sr 90 or Sr uptake from a neutral, highly fertile Hanford sandy loam, or from an alkaline-calcareous sandy loam from Yucca Flat, Nevada Test Site. It appears that further additions of Ca will provide little protection against crop uptake of the radiostrontium fission products from Ca-rich soils.

The Sr/Ca atom ratios and distribution factors for beans were dependent upon the concentration of these cations in the nutrient substrate and the method of assessing plant available Sr and Ca. When adequate levels of Ca were present for plant needs, the Ca content of the plant reached a maximum concentration. Upon further additions of excess Ca, the absorption of Ca proceeded at a reduced rate relative to the rate of Sr absorption, and a discrimination occurred in favor of Sr uptake.

U. of Calif., Los Angeles, Calif.

Menzel, R. G., and Heald, W. R. STRONTIUM AND CALCIUM CONTENTS OF CROP PLANTS IN RELATION TO EXCHANGEABLE STRONTIUM AND CALCIUM OF THE SOIL. Soil Sci. Soc. Amer. Proc. 23: 110-112. 1959.

The relative uptakes of Sr and Ca were determined for crops grown in the field and greenhouse. Exchangeable Sr and Ca contents were determined in 93 plow layer samples representing 51 soil types in 11 widely scattered states. The average ratio was 1.3, with a range of 0.2 to 4.0, Sr atoms per 1,000 Ca atoms. The ratio varied more according to area than according to type of parent rock, and was similar to the ratio in surface water supplies. The ratios of Sr and Ca in alfalfa or wheat grown in the field were nearly equal to those in the exchangeable cations of the soil. Ten species of cultivated plants grown on 4 soils in the greenhouse had Sr and Ca ratios averaging 0.7 times those of the exchangeable cations in the soils. Small, but statistically significant, differences in relative Sr and Ca uptakes were found with different crops and soils.

SWCRD, ARS, USDA, Beltsville, Md.

Foy, C. D. and Barber, S. A. MOLYBDENUM RESPONSE OF ALFALFA ON INDIANA SOILS IN THE GREENHOUSE. Soil Sci. Soc. Amer. Proc. 23: 36-39. 1959.

Greenhouse experiments were conducted to determine the response of alfalfa to Mo on Indiana soils.

Twenty-five soils, representing 18 soil types from the major soil areas of Indiana, were used. The pH of the soils ranged from 4.8 to 7.4. Treatments included combinations of no lime; 250 pounds of  $\text{CaCO}_3$  per acre, mixed with the surface inch of soil; limed according to soil test; no Mo; and 2 pounds of Mo per acre. Three cuttings of alfalfa were obtained.

Mo produced significant yield increases on 9 of the 18 soil types studied, and 7 other gave responses approaching significance. A significant response to Mo was obtained at



the high rate of lime on 2 soils, and on 6 other soils increases were obtained which approached significance. This suggests a deficiency of total Mo in these soils. Mo treatment reduced alfalfa yields on 3 of the acid soils which received the high rate of lime and on 1 soil having an initial pH of 7.0.

Results with one soil indicated that drying prior to cropping increased the response to Mo.

J. Paper No. 1181, Purdue U. Agr. Expt. Sta., Lafayette, Ind.

Askew, H. O., Monk, R. J., and Watson, J. MOLYBDENUM DEFICIENCY OF THE HOP. New Zealand J. Agr. Res. 1:553-568. 1958.

A necrosis of hop leaves, eventually leading to a white speckling of the lamina, has been identified as a result of a deficiency of available soil molybdenum.

Applications of sodium molybdate at 16 oz. per acre were very effective in overcoming the ailment. Ground limestone at 1800 lbs. per acre was also very beneficial, but not quite to the same degree as sodium molybdate.

Leaves showing the symptoms contain only about 0.002 p.p.m. molybdenum in the dry matter of the whole lamina. Levels of other minor elements--copper, zinc and manganese--do not appear to be related to the incidence of leaf symptoms.

Improvement in health of leaves and growth of plants is correlated positively with increased molybdenum content of the leaves whether that increase is brought about by use of sodium molybdate or of ground limestone. Molybdenum content of the cones is similarly increased.

There is a suggestion in the data that size of cones may be increased, and that the sugars contents of cones may be reduced, following use of sodium molybdate.

Cawthron Inst., Nelson, New Zealand.

Askew, H. O., Chittenden, E., Watson, J., and Waters, A. J. INFLUENCE OF APPLICATIONS OF SODIUM MOLYBDATE AND GROUND LIMESTONE ON NEWLY SOWN PASTURE. New Zealand J. Agr. Res. 1: 874-895. 1958.

On a newly sown pasture treated with superphosphate four replications of applications of ground limestone at 0, 1, 5, 10, 20, and 40 cwt (112 lbs) were set out; across these limed strips sodium molybdate at 0, 1, 2 and 4 oz. per acre was applied, giving 24 treatments per replication.

At low rates of liming, sodium molybdate increased clover growth more than at high rates; there was no advantage in applying more than 2 oz sodium molybdate per acre. Increasing the rate of application of limestone improved the growth of the pasture even in absence of molybdate.

Three years after application, all plots carried the same amount of fodder in the spring.

Nitrogen, phosphorus, and calcium contents of white-clover leaflets varied relatively little with treatment.

Manganese content was reduced by liming, but was little altered by variation in rate of application of molybdate. Manganese decreased as molybdenum content increased. A logarithmic relationship between manganese content and rate of use of limestone was found.

Molybdenum content was increased by successively larger applications of ground limestone in the absence of molybdate treatment, and by use of sodium molybdate. Logarithmic relationships between molybdenum content of white-clover leaflets and rate of application of sodium molybdate and also rate of use of limestone were found.

pH value and exchangeable calcium of the soil were increased by use of limestone, but citric-soluble phosphorus and potassium and exchangeable potassium and magnesium were reduced by such treatment. These results are important in relation to interpretation of analytical data in advisory work.

Cawthron Inst., Nelson, New Zealand.

Pearson, G. A., and Bernstein, L. INFLUENCE OF EXCHANGEABLE SODIUM ON YIELD AND CHEMICAL COMPOSITION OF PLANTS: II. WHEAT, BARLEY, OATS, RICE, TALL FESCUE, AND TALL WHEATGRASS. Soil Sci. 86: 254-261. 1958.

The relative tolerance of four grain (Ramona wheat, California Mariout barley, Shasta oats, and Caloro rice) and two grass crops (tall fescue and tall wheatgrass) to increasing levels of exchangeable Na has been studied on two soils of contrasting exchange capacities.

Yield is related to the exchangeable Na percentage rather than to the absolute amount of exchangeable Na present.

The relative tolerance of the crops studied is as follows: tall wheatgrass > barley > wheat > rice > tall fescue > oats.

Increasing Na and decreasing Ca and K concentrations in the plant material were associated with increasing ESP values.

Changes in yield and ionic compositions are related to increasing ESP values, but the relative tolerance of the crops studied does not appear to be consistently related to mineral nutrition.

U. S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif.

Huffaker, R. C., and Wallace, A. SODIUM ABSORPTION BY DIFFERENT PLANT SPECIES AT DIFFERENT POTASSIUM LEVELS. Soil Sci. 87: 130-134. 1959.

Plant species differences and K levels in the nutrient solutions have generally been considered the major factors, other than Na level, influencing Na absorption by plants. The studies reported here were designed to test the relative importance of each with some so-called Na accumulator and non-accumulator plants.

The ability of corn and soybean to inhibit the passage of Na from roots into the respective aerial parts seemed to be influenced by both K levels and Na levels in the nutrient solution.

Radish accumulated more Na\* in the shoots than in the roots at all K and Na concentrations except where both were low. The inhibition of Na absorption by K was less in radish than that found in the other species. Soybean leaves accumulated very little Na\* relative to stem and roots.

Shoot-root ratios for Na\* were different for corn compared with the other two species, in that for each Na level in the nutrient solution the ratios tended to increase at moderate levels of K and decreased at high levels of K. In soybean and radish the ratios tended to increase with increasing K although there were interactions.

Plant species differences seemed more important than K level in determining the amount of Na found in the aerial parts of the plant. K level appeared more important than plant species differences in determining the amount of Na in the roots, since all the plants tested accumulated considerable Na in the roots.

A kinetic treatment of the data indicated that the theoretical maximum amount of Na that the species would absorb under the conditions at an infinite substrate concentration of Na was several times as much for radish as for the other two species. Kinetic curves indicated that the nature of K inhibition on Na absorption was "competitive" in that both appear to be bound at the same site in the root. A natural mathematical consequence of "competitive" inhibition is that the higher the Na level the more difficult it is to effectively exclude it from plants by the use of K.

\*-two Na isotopes.

U. of Calif., Los Angeles, Calif.

Jordan, H. V., and Bardsley, C. E. RESPONSE OF CROPS TO SULFUR ON SOUTHEASTERN SOILS. Soil Sci. Soc. Amer. Proc. 22: 254-256. 1958.

A regional project was begun in 1953 to study sulfur supplies and requirements for crops in the Southeastern States. Typically the Red-Yellow Podzolic soils of this area contain 3 ppm. or less of extractable sulfur in the plow layer although there are accumulations of larger amounts in some deeper horizon. In the southern tier of states, rainfall

contributes about 5.4 pounds of sulfur per acre annually. These amounts fail to meet the needs of high sulfur-requiring crops, and without substantial additions in fertilizers or otherwise the soils are potentially sulfur deficient. Responses to sulfur applications were obtained in 10 to 29 field experiments with cotton, clover, clovergrass combinations, and tobacco.

Cotton, clover, and tobacco absorb sulfur readily as increasing amounts are applied with fertilizer. A tentative threshold value for adequately nourished cotton is about 0.20% sulfur in leaves and petioles in mid-August. A corresponding value for clover is about 0.15%.

SWCRD, ARS, USDA, and Miss. Agr. Expt. Sta., State College, Miss.

Tikhova, E. P. THE IMPORTANCE OF EXCHANGEABLE CATIONS IN THE ADSORPTION OF  $\text{SO}_4^{=}$  BY SOILS. Soviet Soil Sci. 2: 165-168. Feb., 1958.

Many investigators have established that the quantity of phosphoric acid anions adsorbed is closely dependent on the composition of exchangeable cations in the adsorbing complex of the soil.

It must be assumed that soils which are saturated with different cations will not react the same with sulfuric acid or its salts.

The author made the following conclusions:

1. Soils (peat-podzolic, leached chernozem, and chestnut) saturated with iron, barium, calcium, and hydrogen have a higher adsorptive capacity for sulfate ions than the corresponding natural soils; but soils saturated with sodium in all cases adsorb less sulfate ions than natural soils. The exchangeable cations are in the following descending order with respect to the size of their effect on  $\text{SO}_4^{=}$  adsorption:  $\text{Ba} > \text{Fe} > \text{H} > \text{Ca} > \text{Na}$ .

2. Soils saturated with iron adsorb  $\text{SO}_4^{=}$  chiefly by physiochemical means, while barium- and calcium-saturated soils do this by physiochemical and chemical means. The adsorption of sulfate ions by sodium-saturated soil is probably caused by phenomena of a mechanical nature when the colloids are flocculated.

3. The experiments carried out are evidence that the amount of sulfate ions in the soil solution of natural soils depends on the composition of exchangeable cations.

Amer. Inst. of Biol. Sci., 2000 P. St., N. W., Washington 6, D. C.

Kubota, J. COBALT STATUS OF SOILS OF SOUTHEASTERN UNITED STATES:

- I. COBALT, ITS DISTRIBUTION AND RELATIONSHIP TO IRON AND CLAY IN FIVE SELECTED SOILS. Soil Sci. 85: 130-140. 1958.

The distribution of soil cobalt and its relationship to iron and clay were studied in five selected soils of the lower Atlantic coastal plain of southern United States where cobalt deficiency in cattle has been reported. The distribution pattern of total cobalt, total iron, and clay was found to be markedly similar in the soils studied. Iron increases exponentially with changes in cobalt and clay in all horizons of the low humic-gley soils.

The same relationship holds for the  $\text{B}_h$ ,  $\text{B}_t$  and  $\text{A}_2'$  horizons of the ground-water podsols. The relationship was not measurable between clay and either cobalt or iron in the  $\text{A}_1$  horizon of the ground-water podsols; that for clay and cobalt was not measurable in the  $\text{A}_2$  horizon. The consistently low amounts of cobalt found in the ground-water podsols suggest that these are the problem soils in reported areas of cobalt deficiency in parts of the lower coastal plain.

SWCRD, ARS, USDA, U. S. Plant, Soil, and Nutrition Lab., Ithaca, N. Y.

Miller, M. H., and Ohlrogge, A. J. WATER-SOLUBLE CHELATING AGENTS IN ORGANIC MATERIALS: I. CHARACTERIZATION OF CHELATING AGENTS AND THEIR REACTIONS WITH TRACE METALS IN SOIL. Soil Sci. Soc. Amer. Proc. 22: 225-228. 1958.

Water extracts of barnyard manure, dried and ground alfalfa, and animal feces were found to contain complexing agents which were capable of removing zinc from the soil. This zinc could not be removed by water or a potassium chloride solution, but could be removed with a cupric chloride solution. The complexing agents or combination of agents



appear to be of plant origin, and were partially inactivated by incubation of the organic material prior to extraction.

It was shown by the principle of resin-exchange equilibrium that the zinc after removal from the soil was complexed by materials in the water extract of manure. There were at least two complexing agents in the extract, one or more of which formed a 2:1 type of complex and one or more of which formed a 1:1 complex, the resulting average being 1.55:1. The "apparent" stability constant of the combination of agents for zinc was found to be 7.8. The ability of the extract to complex zinc increased as the pH of the extract was increased. The formation of a chelate complex between the zinc and the chelating agents in the extract is postulated.

J. Paper No. 1179, Purdue U., Lafayette, Ind.

Miller, M. H., and Ohlrogge, A. J. WATER-SOLUBLE CHELATING AGENTS IN ORGANIC MATERIALS: II. INFLUENCE OF CHELATE-CONTAINING MATERIALS ON THE AVAILABILITY OF TRACE METALS TO PLANTS. Soil Sci. Soc. Amer. Proc. 22: 228-230. 1958.

Water extracts of barnyard manure, when added to nutrient solutions, greatly decreased the absorption of zinc and iron during a 72-hour absorption period. It was concluded that chelating agents held the zinc and iron in a form that was less available to plants than ionic forms and that the complexing agent did not increase the mobility of the metal within the plant. Additions of manure and a water extract of manure to a Brookston soil decreased the availability of zinc and copper in the soil, but increased the availability of manganese to the plants. It could not be determined from the data obtained whether or not the increased manganese availability could be attributed to the presence of the chelating agents in the extract.

J. Paper No. 1180, Purdue U., Lafayette, Ind.

Foy, C. D., and Barber, S. A. MAGNESIUM DEFICIENCY AND CORN YIELD ON TWO ACID INDIANA SOILS. Soil Sci. Soc. Amer. Proc. 22: 145-148. 1958.

Field experiments were conducted on two acid, sandy loam soils of northern Indiana (Newton, pH 4.7 and Tracy, pH 4.8) to determine the influence of magnesium, calcitic lime, and potash on yields, magnesium deficiency symptoms, and leaf composition of corn. Treatments included factorial combinations of 100 and 500 pounds  $K_2O$ , 0 and 72 pounds Mg (as  $MgSO_4 \cdot 7 H_2O$ ), and 0 and 6 tons of calcitic bag lime per acre.

On the Newton soil both potash treatments induced widespread magnesium deficiency symptoms. Their identity was confirmed by low magnesium and high potassium contents of leaves. The occurrence of magnesium deficiency symptoms was not accompanied by a reduction in corn yield. Magnesium additions essentially prevented development of the symptoms, significantly increased the percentage of magnesium, and decreased the percentage of potassium in leaves, but did not affect yields. On the Newton soil calcitic lime produced significant yield increases, but did not significantly affect K-induced magnesium deficiency symptoms nor percentage of magnesium in the leaves.

On the Tracy soil only a few plants showed magnesium deficiencies, and none of the potash, lime, or magnesium treatments significantly affected yields. The evidence indicates that yield-limiting magnesium deficiency symptoms with corn are not likely to result from the use of calcitic lime and potash in amounts presently recommended on these soils.

Purdue U. Agr. Expt. Sta., Lafayette, Ind.

Hoff, D. J., and Mederski, H. J. THE CHEMICAL ESTIMATION OF PLANT AVAILABLE SOIL MANGANESE. Soil Sci. Soc. Amer. Proc. 22: 128-132. 1958.

Nine methods of extracting manganese from 25 soils were studied and correlated with manganese absorbed by soybean plants. Two of the methods, extraction with 0.1N<sub>3</sub>  $H_3PO_4$  and 3N  $NH_4H_2PO_4$  for 1 hour at a 1:10 soil/solution ratio, were developed during the investigation.

Of the nine methods investigated, extraction of soil manganese with  $\text{NH}_4\text{H}_2\text{PO}_4$ , alcoholic hydroquinone, and  $\text{H}_3\text{PO}_4$  yielded the highest correlation coefficients (0.856 to 0.899), had the smallest variances, and as a group were statistically different from extraction with  $\text{NH}_4\text{OAc}$ ,  $\text{NaOAc}$ , and total soil manganese as methods of estimating plant available manganese. The ammonium dihydrogen phosphate extraction method with the highest correlation coefficient (0.899) was statistically different from methods of extracting soil manganese with  $\text{H}_2\text{SO}_4$ , hydroquinone in  $\text{NH}_4\text{OAc}$ ,  $\text{HNO}_3$ ,  $\text{NH}_4\text{OAc}$ ,  $\text{NaOAc}$ , and total soil manganese.

Results indicate that manganese deficiency in soybeans may be expected if the manganese extracted with ammonium dihydrogen phosphate or phosphoric acid is less than 40 pp2m. With alcoholic hydroquinone, manganese deficiency may be expected if the manganese extracted is less than 125 pp2m.

Ohio Agr. Expt. Sta., Cincinnati, Ohio

Hortenstine, C. C., Ashley, D. A., and Wear, J. I. AN EVALUATION OF SLOWLY SOLUBLE BORON MATERIALS. Soil Sci. Soc. Amer. Proc. 22: 249-251. 1958.

Five slowly soluble boron frits were tested with cotton, soybeans, turnips, alfalfa, and crimson clover grown on Norfolk loamy sand and Lloyd clay loam soils under greenhouse and field conditions. The frit, FN-215A, was not sufficiently soluble to provide adequate boron to plants from applications as high as 50 pounds of the material per acre. FN-176C was more soluble than FN-215A, but it was not a satisfactory source of boron for alfalfa. Both greenhouse and field tests showed that FN-176E and 176-F were the most desirable sources of boron of the frits tested. From tests conducted, FN-176B was the most soluble source and the one most likely to cause toxicity to sensitive plants.

The order of decreasing boron availability was 176B, E, F, C, and 215A. This is also the order of decreasing water solubility as measured by the Rate-of-Solution-Test.

Ala. Polytech. Inst. Agr. Expt. Sta., Auburn, Ala.

Holden, E. R. GLASS AS A BORON SOURCE RELATIONSHIP OF SURFACE AREA AND PARTICLE-SIZE DISTRIBUTION OF BOROSILICATE GLASSES TO BORON STATUS OF ALFALFA. Agr. and Food Chem. 7: 756-762. 1959.

The effect of varying particle size of slowly soluble borosilicate glasses on crop boron was investigated in a greenhouse experiment by growth of alfalfa from Evesboro soil to which the test materials were added. Boron content in all harvests of the crop varied directly with specific surface area of a glass having low chemical reactivity. As the chemical reactivity of the glasses increased, peak effectiveness shifted from the finest to the intermediate and then to the coarsest sieve fractions of glass. Peak effectiveness also shifted, more or less gradually, to coarser particles of glass as the length of time in the soil increased. Uniformly sized particles of moderately reactive glasses had greater ability of minimize seasonal variation in crop boron than comparable nonclassified particles.

The data show that there exists for each glass composition a particular optimal particle diameter which will exhibit a higher degree of performance in single season use than any combination of differently sized particles. Below this optimal diameter much, if not all, of the advantage of using a glass carrier is lost, because the added boron dissolves too rapidly. Above this diameter, part of the added boron cannot be utilized in the initial season, because it remains in an undissolved condition. However, in the latter case, the benefit to be derived from slow release may not be regarded as completely lost. The unsolubilized glass remaining in the soil will continue to release boron slowly for crops of subsequent seasons. On the basis of these considerations, the most suitable mill products were the 2-hour grind of 176-C, and the 0.5-hour grinds of 176-E and -F. The average effectiveness of these materials relative to borax was  $0.6 \pm 0.1$  in the first two harvests. Over-all performance of such glass carriers can be improved greatly by narrowing the particle size range.

SWCRD, ARS, USDA, Beltsville, Md.

Fox, E. J., and Hill, W. L. FACTORS AFFECTING FLUORINE VOLATILIZATION DURING ACIDULATION OF PHOSPHATE ROCK WITH SULFURIC AND PHOSPHORIC ACIDS. Agr. and Food Chem. 7: 478-483. 1959.

The evolution of fluorine in the reaction of phosphate rock with sulfuric and phosphoric acids is affected by the following factors: amount and concentration of sulfuric and phosphoric acids, initial acid temperature, order and type of mixing of the reagents, the presence of water, and the acid-rock ratios. The determination of fluorine and the mechanism governing its release are also considered.

SWCRD, ARS, USDA, Beltsville, Md.

Robertson, W. K., Hutton, C. E., and Thompson, L. G. RESPONSE OF CORN IN SUPERPHOSPHATE PLACEMENT EXPERIMENT. Soil Sci. Soc. Amer. Proc. 22: 431-434. 1958.

Phosphorus was placed 2, 8, 14, and 20 inches deep in Norfolk loamy fine sand and Red Bay fine sandy loam.

In dry years the deeper treatments gave significantly more corn than the shallow treatments when the surface soil had residual fertilizer phosphorus, except on the Red Bay fine sandy loam where placement in the 8-inch level gave a lower yield than the 2-inch level. This was probably because the placement was in the plow sole area which was so compact that roots could not develop. When no residual phosphorus was present on Red Bay soil, the 2-inch treatment gave the best yields. This was because there was not enough phosphorus in the surface soil to promote growth of roots to the fertilizer band and the corn receiving the deeper placements was not stimulated.

In wet years corn was able to get sufficient phosphorus from residual fertilizer to promote root penetration, and subsoiling alone was as effective in increasing corn yields as was applied phosphorus.

Fla. Agr. Expt. Sta., Gainesville, Fla.

Kamprath, E. J., and Miller, E. V. SOYBEAN YIELDS AS A FUNCTION OF THE SOIL PHOSPHORUS LEVEL. Soil Sci. Soc. Amer. Proc. 22: 316-319. 1958.

A survey was conducted to determine the relationship between the yield of soybeans and the nutrient level of the soil. The yield of soybeans was related to the soil phosphorus level and the soil pH. When the yields of soybeans were placed into the various soil test categories for phosphorus, it was found that the lowest average yield was in the low soil phosphorus category and the highest average yield in the high soil phosphorus range.

Studies in the greenhouse also showed that the yields of soybeans were related to the soil phosphorus level. The response of soybeans to the addition of phosphorus was dependent upon the soil phosphorus level.

A much better evaluation of the effect of the phosphorus level of the soil on the yield of soybeans was obtained by placing the soils into categories ranging from low to very high than was obtained by use of rank correlation.

N. C. Agr. Expt. Sta., Raleigh, N. C.

Russell, R. S., Russell, E. W., and Marais, P. G. FACTORS AFFECTING THE ABILITY OF PLANTS TO ABSORB PHOSPHATE FROM SOIL. J. Soil Sci. 9: 100-108. 1958.

Barley, rye, and cabbage have been used as test plants to measure labile soil phosphate by the Larsen procedure. In some soils higher values are given by rye and cabbage than by barley. These differences are believed to reflect the greater ability of cabbage and rye to lower the free energy of phosphate in the external medium. Thus, in soils containing large quantities of labile phosphate at a low potential, sources of phosphate that are inaccessible to barley are accessible to the other two species.

Dept. Agr., U. Oxford, England.



The importance of mineral fertilizers in the agriculture of the USSR is increasing every year. For a number of years cotton, sugar beets and other technical crops have been abundantly supplied with mineral fertilizers. Nitrogen is applied under cotton in the form of mineral fertilizer in an amount equal to that which is removed with the cotton crop, while more than twice as much phosphorus is applied under cotton as is removed and more than three times as much phosphorus is applied with fertilizers under sugar beets as is removed with the crop. Further, the number of sowings intensively fertilized with phosphorus will increase. For this reason, the question of the availability of phosphates remaining in the soil after removal of the crop is acquiring great national economic significance.

The author made the following conclusions:

1. Setting up vegetative experiments with the application of  $P^{32}$  (with a negligible quantity of carrier) makes it possible to characterize the supply of available phosphates in the soils and the degree of their mobility.
2. Depending on the type of soils available phosphates are not uniformly mobile, and for this reason the supply of phosphorus to the plants in different soils must vary depending on the amount of available phosphates supplied.
3. When applied to the soil water-soluble phosphates are generally converted into exchangeable available phosphates with a degree of mobility which corresponds to a given type of soil.
4. Determination of available mobile phosphates by the use of slightly acid and other extracts of the soil causes secondary precipitation at the time of extraction and thus gives a considerably underestimated idea of the solubility of soil phosphates. This was established by analyses in which the radioactive label was added to the extracts.
5. In regions where phosphorus fertilizers are used intensively, there is vigorous accumulation of available phosphates in soil requiring reconsideration of the methods of applying phosphates.
6. Previously held ideas about the extremely low utilization coefficient of the phosphorus in fertilizers, and about the quick reversion in the soil of superphosphate with its conversion to forms which are not available to plants, are not realistic.

Amer. Inst. of Biol. Sci., 2000 P St., N. W., Washington 6, D. C.

Lehr, J. R., Brown, W. E. and Brown, E. H. CHEMICAL BEHAVIOR OF MONO-CALCIUM PHOSPHATE MONOHYDRATE IN SOILS. Soil Sci. Soc. Amer. Proc. 23: 3-7. 1959.

To gain an insight into the phenomena that are initiated when superphosphate is placed in soil, tablets containing monocalcium phosphate monohydrate were placed in several soils (Hartsells fsl, Ruston fsl, Carrington sil, Webster sil and Dewey sil) and observed directly. Petrographic examinations and supporting chemical studies gave information on chemical reactions associated with the dissolution process and on the transport of materials to and from the tablet--factors that bear upon the distribution and chemical combination of the phosphorus and thus upon agronomic response.

The results suggest that capillary flow was a principal mechanism in the movement of phosphate solution away from the tablet. Vapor-phase transport of water to the tablet apparently controlled the rate of dissolution. A significant part of the P remained at the tablet site as dicalcium phosphate, anhydrous and dihydrated. The dissolution process was affected by soil type, soil moisture content, humus content, microbiological activity, capillarity of soil and tablet, time, and temperature.

Div. of Chemical Devlpmt., TVA, Wilson Dam, Ala.

Godfrey, C. L., Fisher, F. L., and Norris, M. J. A COMPARISON OF AMMONIUM METAPHOSPHATE AND AMMONIUM ORTHOPHOSPHATE WITH SUPERPHOSPHATE ON THE YIELD AND CHEMICAL COMPOSITION OF CROPS GROWN UNDER FIELD CONDITIONS. Soil Sci. Soc. Amer. Proc. 23: 43-46. 1959.

Sweet Sudan and Iron-Clay cowpeas were grown under irrigation in the field on a Lufkin fine sandy loam, an acid Planosol, and on a San Saba clay, a highly calcareous Grumusol (Rendzina). The plots were fertilized with 50-30-60 per acre, with the check receiving 50-0-60. The treatments consisted of ammonium sulfate, ammonium orthophosphate, ammonium metaphosphate, 20% superphosphate, muriate of potash, and calcium sulfate, applied in such a way as to give a valid comparison between the ammonium phosphates and superphosphate. The forage from one-half the area of each plot was harvested 4 weeks after planting and the remainder at the end of 8 weeks. Forage yields and chemical composition were determined.

Crops at both locations responded to all P treatments, with the Sudan yields being increased about 90% over the check in contrast to only about a 10 to 15% increase by the cowpeas. The greatest yield response was by Sudan on the San Saba clay; the least response was by the cowpeas, also on the San Saba clay. All sources of P were about equal in their separate effect on crop yields at each location.

The P content of the separate crops was increased about the same by each source of P, but the P content was highest in the crops grown on the acid Lufkin fine sandy loam. The P content of the cowpeas grown on the San Saba clay was not appreciably affected by P additions.

The N, S and Ca levels in the forage were not affected by the P treatments, but were affected by location and species, and were greatly affected by the stage of maturity at harvest, the less mature forage being higher in these nutrients.

Charts and Graphs.

Tex. Agr. Expt. Sta., College Station, Tex.

Cullen, N. A. A COMPARISON OF PHOSPHATIC FERTILIZERS. New Zealand J. Agr. Res. 1: 418-431. 1958.

A trial was laid down in February 1951 at Invermay Research Station to investigate pasture responses from several forms of phosphatic fertilizers in the presence and absence of lime.

The phosphatic fertilizers used were superphosphate, serpentine superphosphate, Thermophos, and North African and Nauru groundrock phosphates. Lime treatments were: nil, 10 cwt, (1120 lbs.) and 20 cwt, 2240 lbs. annually.

Over a five year period, Thermophos and serpentine superphosphate gave similar yields to superphosphate when compared on the basis of equivalent amounts of  $P_2O_5$  per acre.

North African phosphate proved comparable to superphosphate in the absence of lime, but inferior in the presence of lime. Nauru rock phosphate proved inferior to the other treatments.

Lime increased yields slightly in the superphosphate, serpentine superphosphate, and Thermophos plots, but depressed yields in the North African and Nauru rock-phosphate treatments.

Invermay Res. Sta., Mosgiel, New Zealand.

Saunders, W. M. H. THE EFFECT OF DIFFERENT PHOSPHATE FERTILIZERS ON SOIL pH AND THE CONSEQUENT EFFECT ON PHOSPHATE RETENTION. New Zealand J. Agr. Res. 1: 675-682. 1958.

A comparison has been made of the degree of phosphate retention by yellow-brown loam of different phosphate fertilizers--superphosphate, double superphosphate, potassium dihydrogen phosphate and diammonium phosphate. The soils used were of low, medium and high phosphorus status. The addition of the phosphate to the soil suspension alters the pH, and the differences between the pH values of the suspensions are sufficient to account for the differences in phosphate retention.

To determine how long these differences in pH persist, a low and a high phosphorus status soil were topdressed in a laboratory experiment at 90 lb P/acre and the pH of the surface soil measured over a period of three months changes of over one pH unit were recorded after topdressing, and it is considered that even under light topdressing in the field, these pH changes would occur in the immediate vicinity of the phosphate particles and affect the concentration of phosphate in the soil solution and the utilization of the applied phosphate.

Soil Bur., Dept. Sci. and Indus. Res., Wellington, New Zealand.

Fedorovskii, D. V. SECRETION OF LABELLED PHOSPHORUS AND CALCIUM FROM THE ROOTS INTO THE SOIL IN ROOT-FED PLANTS. Soviet Soil Sci. 3: 231-236. March, 1958.

A study was made, in the greenhouse, to determine the amount of substances secreted into the soil with "normal" root feeding. The root systems of plants were divided equally into two separate sections of soil from which the roots were simultaneously nourished. A NPK fertilizer was applied to one of the containers and NPK, plus radioactive phosphorus to the other. At the end of the experiment, the soil in the container to which the radioactive phosphorus had not been applied was analyzed and the presence of the tracer was always detected. This can be explained only by secretion.

The following conclusions were made:

1. Secretion into the soil of radioactive phosphorus and calcium, which had been taken up by plants through isolated strands of roots from soil fertilized with labelled fertilizer, was found in all experiments.

2. The amount of labelled phosphorus secreted from the roots in experiments with young corn plants was 2 to 7 mg. of  $P_2O_5$  (from 4 to 25% of the content of labeled phosphorus in the plants). The total amount of phosphorus secreted into the soil exceeded its content in the roots, but the radioactivity per gram of the roots was 20 to 30 times as high as the radioactivity per gram of soil.

3. Phosphorus secretion from roots to soil was influenced by its content in the plant and the age of the plant as well as by certain soil conditions determining the uptake of this element.

Increased osmotic pressure of the soil solution, which sharply decreased the uptake of water from the soil, was reflected only weakly on the uptake of phosphates and caused no change at all in the secretion of  $P_2O_5$  into the soil. Approximately equal quantities of labelled phosphorus were taken up by plants from chernozem and sierozem. The secretion of phosphorus taken up from chernozem proved to be somewhat greater than that taken up from sierozem.

4. The amount of phosphorus secreted from the roots did not depend on the properties of the soil into which the secretion took place.

5. The secretion of the labelled calcium of the roots, like that of phosphorus, did not depend on the properties of the soil into which it was secreted, but it did depend on the amount of this element in the plant and on the properties of the soil from which the labelled calcium was taken up.

6. The uptake of Ca by plants and its accumulation in them depended to a greater degree than did phosphorus on the properties of the soil: more Ca was taken up from sierozem than from chernozem. Its translocation from one part of the root system to another took place less extensively than did that of phosphorus.

Amer. Inst. of Biol. Sci., 2000 P St., N. W., Washington 6, D. C.

Chang, S. C., and Jackson, M. S. SOIL PHOSPHORUS FRACTIONS IN SOME REPRESENTATIVE SOILS. J. Soil Sci. 9: 109-119. 1958.

The distribution of soil inorganic phosphorus in soils was found to measure the degree of chemical weathering, the chemical weathering sequence being calcium phosphate, aluminium phosphate, iron phosphate, and occluded phosphate. The latter category includes reductant soluble iron phosphate and aluminum-iron phosphate occluded in iron oxides. For example, three horizons of one Chernozem profile, a dark brown soil, and the calcareous  $C_1$  horizon of a Grey-Brown Podzolic soil contained 68-95 percent of their



inorganic phosphorus in the form of calcium phosphate, the other forms decreasing exponentially in the sequence. The inorganic phosphorus of two Latosols increased exponentially in the order calcium phosphate (1%) of aluminum phosphate (0-3%), iron phosphate (10-13%), occluded (reductant soluble) phosphate (66-78%). Three samples of podzolized soils contained intermediate, sigmoidal distributions of the four phosphates.

In two Miami silt loam profiles, the 0.002 N  $\text{H}_2\text{SO}_4$ -extractable-phosphorus test was much higher in the subsoils down to 3 1/2 ft. than in the surface soil, and was correlated mostly with the calcium-phosphate content, somewhat with aluminium and iron phosphate, and none at all with occluded phosphates which constituted a high percentage of the total phosphorus. The higher content of available phosphorus in the subsoils and release of phosphorus in the surface soil by decrease of Al and Fe activity through liming most probably explain the lack of crop response to added phosphate fertilizer even though the surface soil had a low phosphorus test.

Application of phosphate fertilizer to Almena silt loam greatly increased the amount of aluminium and iron phosphate at three lime levels; only a slight increase of calcium phosphate occurred, at the highest lime level. The amount of occluded phosphate remained unchanged by liming or fertilization. The relatively small increase of calcium phosphate through phosphate application is attributable partly to crop removal but is shown to be due mostly to formation of the less soluble iron and aluminium phosphates.

U. Wisc., Madison, Wisc.

Talibudeen, O. ISOTOPICALLY EXCHANGEABLE PHOSPHORUS IN SOILS, III. THE FRACTIONATION OF SOIL PHOSPHORUS. J. Soil Sci. 9: 120-129. 1958.

Phosphate residues in the soil were subdivided into three fractions on the basis of isotopic exchange of orthophosphate ions between the soil and the soil solution. It was observed that the total labile phosphorus was a smaller fraction of the total phosphorus in the heavier soils (c. 20 percent clay) than in the lighter soils (1-10 percent clay). This could be partly attributed to a higher organic-phosphorus content in the heavier soils. In comparable soils, recent manuring with superphosphate increased the ratio of the rapidly labile phosphate to the total labile phosphate; in the soils of lower clay content, this ratio was higher than the corresponding ratios in the heavier soils. The recovery of phosphorus added at a moderately heavy rate was estimated by this method of fractionation in soils incubated for periods up to 3 months after treatment. Recovery of added phosphorus in the total labile fraction was incomplete for the calcareous soils, as compared to a 100 percent recovery in a neutral soil of similar clay content. Moreover, a redistribution of phosphorus with time was observed in the calcareous soils within the total labile fraction, no such effect being observed with the neutral soil. This was attributed to the presence of internal surfaces on the calcium carbonate present.

Rothamsted Expt. Sta., Harpenden, England.

Hagen, C. E. PHOSPHATE ABSORPTION BY PLANT ROOTS. Atomic Energy Comm. Rpt. T1D-7512: 303-307. 1956.

The understanding of ion absorption by plants is essential to a solution of problems involving the relationships of soils and plants. The diverse responses of plant species and varieties to the same soil environment indicate a selectivity of ion absorption by plant roots. The metabolism of a plant was early recognized to be involved in the absorption of ions. These known facts can be interpreted in terms of an hypothesis derived from the relations of simple chemical reactions. Deductive reasoning based on the hypothesis leads to experiments giving supporting evidence for the hypothesis and further insight into the process of ion absorption.

SWCRD, ARS, USDA, Beltsville, Md.

Perkins, A. T. EFFECT OF PHOSPHATE ON THE CATION-EXCHANGE CAPACITY OF MINERALS AND SOILS. Soil Sci. Soc. Amer. Proc. 22: 509-510. 1958.

The cation-exchange capacity of several soil minerals and fertilizer compounds has been determined. The exchange capacity of iron and aluminum phosphates was found to be

approximately the same as or somewhat greater than that of Wyoming bentonite. Phosphate treatment of several horizons of 4 soils (Cherokee, Labette, Dennis and Summitt) was found to increase the cation-exchange capacity of these soils but not in proportion to the amount of phosphate fixed, except in the case of the 6 horizons of the Summitt soil. Eight soil clay minerals or minerals closely related to soil clays were decomposed by grinding and the effect of phosphate treatment of their exchange capacity was determined. In most cases a major increase in cation-exchange capacity resulted from phosphate treatment, but in several cases a lesser numerical but significant decrease occurred. It is concluded that phosphate fertilization can noticeably effect an increase in the cation-exchange capacity of soils.

Kans. Agr. Expt. Sta., Manhattan, Kans.

Foster, W. N. M., and Russell, R. S. FACTORS AFFECTING THE ABILITY OF PLANTS TO ABSORB PHOSPHATE FROM SOILS, III. PLANT-PHYSIOLOGICAL EFFECTS OF IRON. J. Soil Sci. 9: 280-288. 1958.

In water-culture experiments of short duration the transfer of phosphate to plant shoots is reduced by ferric iron applied prior to or simultaneously with phosphate. The effect is more marked in barley than in rye. The retention of phosphate in roots is similar whether iron is applied simultaneously with or prior to phosphate. Variation in the concentration of phosphate which is supplied to plants has no corresponding effect on the retention of iron in roots. The evidence presented is compatible with the view that phosphate is restrained in roots by ferric ions which have already combined with immobile organic molecules. The atom ratio of iron to phosphate in the resultant complex appears to be 1.

No direct evidence is available to show whether reactions between iron and phosphate within plants contribute significantly to the interaction between the two ions which can occur when plants are grown in soils high in labile iron, but this possibility cannot be discounted.

Dept. Agr., U. Oxford, England.

Webb, J. R., and Pesek, J. T. AN EVALUATION OF PHOSPHORUS FERTILIZERS VARYING IN WATER SOLUBILITY: I. HILL APPLICATIONS FOR CORN. Soil Sci. Soc. Amer. Proc. 22: 533-538. 1958.

The degree of water solubility of the phosphorus exerted a marked influence on the growth, phosphorus absorption, and yield of corn in 20 field experiments involving hill fertilization rates of 10 to 30 pounds of available  $P_2O_5$  per acre.

All of the experiments showed consistent trends toward larger yield increases with increasing water solubility of the phosphorus, and a statistically significant source effect was observed in 12 of the 20 experiments. The largest increase in fertilizer effectiveness per unit increase in water solubility was attained with fertilizers having 60% of the phosphorus in a water-soluble form.

Plant height measurements indicated that early season growth response was correlated very closely with phosphorus rates and water solubility. The use of  $P^{32}$  labeled fertilizers in one experiment revealed that the fraction of plant phosphorus derived from the fertilizer increased significantly with increasing phosphorus water solubility. However, rate and source of phosphorus had only a slight effect on the total phosphorus content of leaves sampled at silking time.

Charts and Graphs.

Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Cole, C. V., and Olsen, S. R. PHOSPHORUS SOLUBILITY IN CALCAREOUS SOILS: I. DICALCIUM PHOSPHATE ACTIVITIES IN EQUILIBRIUM SOLUTIONS. Soil Sci. Soc. Amer. Proc. 23: 116-118. 1959.

A theoretical background for the study of P solubility behavior in calcareous soils has been developed. The mean activity of dicalcium phosphate is used to express P

solubility. Calculation of this function corrects for differences in the pH values, Ca concentrations, and ionic strengths which are encountered when a number of soil solutions are compared. The validity of this approach is based on the observation that the ion product,  $a\text{Ca}^{++} \times a\text{HPO}_4^-$ , in various solutions in equilibrium with a given soil remains constant over a range of values of pH, Ca concentration, and ionic strength.

SWCRD, ARS, USDA, Colo. State U., Fort Collins, Colo.

Cole, C. V., and Olsen, S. R. PHOSPHORUS SOLUBILITY IN CALCAREOUS SOILS: II. EFFECTS OF EXCHANGEABLE PHOSPHORUS AND SOIL TEXTURE ON PHOSPHORUS SOLUBILITY. Soil Sci. Soc. Amer. Proc. 23: 119-121. 1959.

P solubility expressed as the mean activity of dicalcium phosphate in equilibrium solutions increases regularly with the amounts of P adsorbed in the monolayer region on the surfaces of various materials likely to be present in calcareous soils. Values of the mean activity of dicalcium phosphate; in equilibrium soil solutions increased as a direct function of the amount of phosphate added as concentrated superphosphate. Differences in P solubility behavior between soils of varying texture are explained by measurements of the surface area and the capacity of the soils for monolayer adsorption of P.

SWCRD, ARS, USDA, Colo. State U., Fort Collins, Colo.

Jaworski, C. A., and Barber, S. A. SOIL PROPERTIES IN RELATION TO POTASSIUM UPTAKE BY ALFALFA. Soil Sci. 87: 37-41. 1959.

An experiment was conducted in the greenhouse on the following soil types; Brookston sil, Miami gritty sil, Reesville sil, and Miami 1 of the gray brown podzolic soil in Indiana, to determine the effect of a number of soil properties on the correlation of exchangeable K with K uptake by the plant. The coefficient of determination for the correlation of exchangeable K with K uptake by the plant was 0.65. When exchange capacity, per cent organic matter, exchangeable Ca and K supplying power are included, the coefficient of determination is increased to 0.82.

The prediction equation obtained for these soils indicate that the predicted uptake of K would increase when exchange capacity decreases, when organic matter increases, when exchangeable Ca increases, and when K supplying power increases. Further research is necessary to prove that these variables are directly influencing the availability of soil K.

J. Paper 1193, Purdue U. Agr. Expt. Sta., Lafayette, Ind.

De Vries, P., and De Wit, C. T. THE EFFECT OF POTASH FERTILIZATION ON DRY MATTER PRODUCTION OF PERMANENT PASTURE THROUGHOUT THE SEASON. Netherlands J. Agr. Sci. 6: 124-130. 1958.

Varying amounts of potassium were applied five times a year to a permanent pasture on sandy soil, a different part of the field being chosen for each occasion. The potassium availabilities of the soil at the time of potassium application was kept at approximately the same level.

It was found that: (1) The relation between uptake and yield differed in successive cuts, but was the same as regards the effect and after effect of the potassium dressing; (2) the effect of potash fertilization in autumn depended to a large extent on the withdrawal of potassium with previous cuts; (3) the existence of a casual relation between temperature and the effect of potassium fertilization was not proved; (4) the availability of potassium at a K-value of about 18 was almost sufficient to enable any growth to take place; (5) the uptake from soil was not determined by growth; (6) the recovery of the potassium fertilizer was to a large extent dependent on growth; (7) except for the first cut the uptake was greater than that needed for reasonable growth; (8) the most favorable treatment would have been a dressing of about 200 kg  $\text{K}_2\text{O}$  per ha (225 pounds  $\text{K}_2\text{O}$  per acre) in spring only.

Inst. for Biol. and Chem. Res. in Field Crops and Herbage, Wageningen, Holland.



Hutcheson, T. B., Jr., Woltz, W. G., and McCaleb, S. B. POTASSIUM-SODIUM INTERRELATIONSHIPS: I. EFFECTS OF VARIOUS RATES AND COMBINATIONS OF K AND Na ON YIELD, VALUE AND PHYSICAL AND CHEMICAL PROPERTIES OF FLUE-CURED TOBACCO GROWN IN FIELD AND GREENHOUSE. Soil Sci. 87: 28-36. 1959.

Greenhouse investigations of the influence of Na and K on the nutrition of flue-cured tobacco grown in sand cultures showed the essentiality of K for normal plant development. Na appeared to have little effect upon plant growth when supplied in nutrient solutions with or without K. When K was either not supplied or supplied at low levels in solutions, the presence of Na was observed to delay the appearance and lessen the degree of severity of K-deficiency symptoms. This same general effect was observed in the field experiments conducted on Norfolk, Durham, and Vance soils at low K levels when rates of Na not exceeding 39.5 pounds of  $\text{Na}_2\text{O}$  per acre were applied. Thus, it would seem that the Na ion at least partially substituted for K in some plant process or processes when K was in low supply.

Even though Na does appear to be involved in plant metabolism to some extent when K is limiting, its effect was not of sufficient magnitude to influence the yield of flue-cured tobacco plants grown in either the field or quartz sand cultures. Price per pound of the cured leaves of field-grown tobacco was increased by applications of up to 39.5 pounds of  $\text{Na}_2\text{O}$  per acre when K was not applied. This effect is probably related to the suppression of marginal burning of the leaves characteristic of K deficiency.

From the results of these investigations, it would not seem feasible to suggest that any of the K normally included in flue-cured tobacco fertilizers be replaced by Na.

Because of the indications that at low levels of K, Na may perform some of the functions in the plant normally performed by K, it would appear advisable to avoid the use of Na in compounding experimental fertilizers to be used in critically evaluated K effects on the nutrition of flue-cured tobacco.

Ky. Agr. Expt. Sta., Lexington, Ky.

DeMent, J. D., Stanford, G. and Bradford, B. N. A METHOD FOR MEASURING SHORT-TERM NUTRIENT ABSORPTION BY PLANTS: II. POTASSIUM. Soil Sci. Soc. Amer. Proc. 23: 47-50. 1959.

The method previously reported for measuring short-term P absorption by plants has been adapted to studies of K uptake in relation to various factors. K-deficient oat or corn plants, grown in sand cultures, were placed in contact with soil or soil-fertilizer mixtures for periods of 1 to 14 days. Recovery in oat tops from applications of 10 to 120 mg. K ranged from 25 to 7% in 3 days to 63 to 30% in 14 days. When K content of roots in sand and in soil also was taken into account, 14-day recoveries from 30- and 120-mg. K additions were 85 and 43% respectively. Despite the wide range in K content of plants, growth differences among treatments were not apparent for at least the first week, as had previously been observed in studies with P.

Unfertilized soils supplied significant amounts of K to plants in 3 days. At 7 days, rather wide differences in K content of plants were evident among soils, indicating the possible utility of the method in assessing the K status of soils. Moisture contents of soils were important in relation to K uptake. Moisture equivalent for each soil appeared to be the near-optimum level.

Availabilities of K in potassium calcium pyrophosphate (KCP), potassium metaphosphate (KMP), and KCl to corn plants were compared in soil and sand. During 1- and 3-day absorption periods, KCl was more available than KMP and KCP in both media. The data suggest that contact with soil increased dissolution of the KMP and KCP. KCl was less available in soil than in sand.

Very high correlations were found between uptake of K by tops and whole plants for a wide range of K rates, absorption periods, and soils. Thus, K content of plant tops is a suitable criterion for assessing relative effects of treatments on K nutrition of the plants.

Div. of Agr. Relat., TVA, Wilson Dam, Ala.

Sutton, P. and Seay, W. A. RELATIONSHIP BETWEEN THE POTASSIUM REMOVED BY MILLET AND RED CLOVER AND THE POTASSIUM EXTRACTED BY 4 CHEMICAL METHODS FROM 6 KENTUCKY SOILS. Soil Sci. Soc. Amer. Proc. 22: 110, 115. 1958.

Six soils, Bedford sl, Maury sl, Pembroke sl, Grenada sl, Tilsit sl and Eden sicl, were cropped in the greenhouse with millet and Kenland red Clover to determine the potassium-supplying power of the soils and the degree of correlation between the potassium removed by the crops and that extracted by four chemical methods. Potassium fertilizer was applied to determine the effect this would have on the potassium-supplying power.

Potassium was extracted from moist and air-dry soil samples with 0.15N  $H_2SO_4$ , 1.38N  $H_2SO_4$ , 1N  $NH_4Ac$  and 1N  $HNO_3$ . The potassium extracted from moist soil samples correlated better than did air-dry soil samples with the amount of potassium removed from the soils by millet. The potassium extracted by 1N  $NH_4Ac$  and 1.38N  $H_2SO_4$  from moist soil samples correlated better than did air-dry soil samples with the amount of potassium removed from the soils by clover. The differences in potassium extracted from moist and dry samples were small for the 0.15N  $H_2SO_4$  and 1N  $NH_4Ac$  methods.

The potassium extracted by 0.15N  $H_2SO_4$  and 1N  $NH_4Ac$  from air-dry soil samples and the potassium extracted by 1.38N  $H_2SO_4$  from moist soils gave the best indexes for evaluating the potassium-supplying power of these soils.

Numerous charts and graphs.

Ky. Agr. Expt. Sta., Lexington, Ky.

DeMumbrium, L. E., and Hoover, C. D. POTASSIUM RELEASE AND FIXATION RELATED TO ILLITE AND VERMICULITE AS SINGLE MINERALS AND IN MIXTURES. Soil Sci. Soc. Amer. Proc. 22: 222-225. 1958.

Fixation and release of K were studied under moist and dry equilibrium conditions. Clay and silt fractions of illite and vermiculite, as single minerals and in mixtures, were used in the experiments. Nonaqueous solutions were compared with aqueous solutions as K extractants to evaluate the effect of rehydration upon K release. The drying of illite increased the amounts of K removed by aqueous solutions and decreased the amounts removed by nonaqueous solutions. Illite fixed no applied K against aqueous extraction, even after drying, but vermiculite fixed large amounts. Silt fractions of illite were nearly as efficient in K releases as were the clay fractions.

Mixtures of illite and vermiculite showed increased exchangeable K upon drying, reversion of this K upon remoistening, and fixation of applied K. These effects were not all present when the minerals were tested singly. The "Attoe effects" were induced in vermiculite-free soil clays by an addition of vermiculite to the sample.

Miss. Agr. Expt., State College, Miss.

Cope, J. T., Jr., Strike, D. G., and Hiltbold, A. E. EFFECTS OF MANURE, VETCH AND COMMERCIAL NITROGEN ON CROP YIELDS AND CARBON AND NITROGEN CONTENTS OF A FINE SANDY LOAM OVER A 30-YEAR PERIOD. Soil Sci. Soc. Amer. Proc. 22: 524-527. 1958.

Annual per-acre treatments of 5 tons of manure, 52 pounds of N as  $NaNO_3$ , and vetch grown annually in a 2-year rotation of cotton and corn were compared during the 17-year period of 1925-41, on Chesterfield fine sandy loam.

Corn yields from the manure, commercial N, vetch and check plots were 44.0, 40.2, 35.1, and 7.3 bushels, respectively. The yields of seed cotton were 1,773, 1,488, 1,418, and 433 pounds respectively.

During 5 years after these treatments were discontinued, residual effects of manure exceeded those of commercial N or vetch by about 14 bushels of corn and 475 pounds of seed cotton. From 1948 through 1955, all plots were in corn and received 80 pounds of commercial N. Yields from all plots were 50 to 60 bushels the first year of this period. Manure increased yields for at least 8 years after the last application.

Total C and N determinations were made on soil samples taken at intervals throughout the 30-year period. C and N levels were maintained about constant on the commercial N and vetch plots, increased on the manure plots, and decreased on the check plots. Levels of C and N in all except the former check plots decreased during the residual study. Eighty pounds of commercial N did not stop the loss of C and N from the manure plots.

Agr. Expt. Sta., Ala. Polytech. Inst., Auburn, Ala.

Dijkshoorn, W. NITROGEN, CHLORINE AND POTASSIUM IN PERENNIAL RYEGRASS AND THEIR RELATION TO THE MINERAL BALANCE. Netherlands J. Agr. Sci. 6: 131-138. 1958.

The results of a pot culture experiment with perennial ryegrass on the effect of increasing nitrogen fertilization at three potassium chloride levels are discussed.

Chloride fertilization caused an increase in the concentration of the anionic and cationic elements in the yield, but did not lend to any change in the cation-anion ratio. With the highest addition of chloride there was no further increase in high cation content when increasing amounts of nitrogen were also added to the dressing. The potassium in the fertilizer had no effect on the total cation concentration in the yield, but only caused an alteration in the relationships of the individual cations.

Increasing nitrogen fertilization caused a decrease in the concentration of the  $Cl + P + S$  anions in the yield and an increase in the nitrogen concentration. The increase in the total anion concept  $Cl + P + S + N$  was relatively greater than the increase in the cation content  $K + Na + Mg + Ca$ , so that with an increasing nitrogen level there was a certain decrease in the cation-anion ratio.

Among the antagonistic effects which counteracted an excessive anion uptake at higher chloride levels there was a reduction in the sulfur content, and at higher nitrogen levels also a reduction in the nitrogen content.

Inst. of Biol. Chem. Res. on Field Crops and Herbage, Wageningen, Netherlands.

Barrows, H. L., and Drosdoff, M. EFFECT OF NITROGEN, POTASSIUM, CALCIUM, AND MAGNESIUM ON MINERAL COMPOSITION OF LAKELAND FINE SAND IN RELATION TO MINERAL CONTENT OF TUNG LEAVES. Soil Sci. Soc. Amer. Proc. 22: 426-431. 1958.

Eight-year-old tung trees growing on Lakeland fine sand were treated from 1949 to 1955 with factorial combinations of 3 sources of N and 2 levels each of N, K, Ca, and Mg. Soil samples collected in October; 1954 showed that exchangeable K was increased to a depth of 36 inches (lowest depth sampled) by the high level of applied K, but was reduced by the high level of Mg. Exchangeable Ca was increased by the high level of Ca, but was reduced by the high level of K or Mg. Exchangeable Mg was increased by the high level of Mg in the 0- to 6-inch depth only. Below 6 inches, it was reduced by the high level of K or Mg.

The chemical analyses of leaves collected in 1955 show the same general trends as those found in the soil. The polynomial equations of degrees  $n = 1, 2, 3$ , and 4 were calculated for the regression of the concentration of K, Ca, and Mg in the leaves on saturation percentage of these elements in the soil. The linear equation for K was significant for each soil depth and the equations of higher degree show no significant improvement. The linear equations for Ca were significant to all depths, but the second-degree equations were an improvement on the linear in the top 18 inches of soil. The linear equations for Mg were significant in the top 18 inches of soil. The second-degree equations were an improvement on the linear in the 6- to 12- and 12- to 18-inch depths.

U. S. Field Lab. for Tung Invest., CRD, ARS, USDA, Bogalusa, La.

Rennie, D. A., and Soper, R. J. THE EFFECT OF NITROGEN ADDITIONS ON FERTILIZER-PHOSPHORUS AVAILABILITY. II. J. Soil Sci. 9: 155-167. 1958.

A field and greenhouse study has been made of the effect of nitrogen on the utilization of fertilizer phosphorus by cereal grains. A marked increase in utilization when nitrogen was mixed with either  $NH_4H_2PO_4$  or  $Ca(H_2PO_4)_2$  was shown to occur only when the nitrogen



was in the ammonium form. Nitrate sources of nitrogen were relatively ineffective. Placement of nitrogen was important as increased uptake only occurred when the ammonium ion was intimately associated with the phosphorus fertilizer. This stimulative effect of the ammonium ion on phosphorus uptake occurred at a very early stage of crop growth.

Rapid ammonium-ion absorption by young cereal seedlings occurred irrespective of whether the ammonium source of nitrogen was mixed with, or separated from, the phosphorus carrier. Thus the ammonium ion appears to be the dominant factor; it indirectly influences the plant's ability to take up phosphorus, rather than altering in any way the availability of the applied phosphorus fertilizer.

U. Saskatchewan, Saskatoon, Saskatchewan, Canada.

Fuller, W. H. and Hannapel, R. THE INFLUENCE OF NITROGEN ON THE UPTAKE OF PHOSPHORUS BY A TOMATO TEST CROP FROM THREE CROP RESIDUES. Soil Sci. Soc. Amer. Proc. 22: 299-302. 1958.

The uptake of phosphorus from wheat straw, tomato vine, and lettuce residues by a tomato test crop as influenced by different rates of nitrogen additions was studied under greenhouse conditions. The residues were grown in sand-nutrient cultures at different levels of phosphorus containing the radiophosphorus. The residues were then incorporated into two calcareous soils in greenhouse pots at rates equivalent to 50 and 100 pounds of  $P_2O_5$  per acre. Nitrogen was applied at rates ranging from 0 to 400 pounds of N per acre 6 inches. The tomato test crop was grown for 9 weeks before harvesting and analyzing.

The results indicated that the percentage of P in the tomato test crop derived from the different residues was not significantly affected by the rate of application of nitrogen to the soil. This circumstance occurred despite the fact that the percentage of nitrogen and phosphorus, and the dry weight of the test crop was influenced by the rate of application of nitrogen fertilizer. The percentage of P in the test crop derived from the crop residues was not affected by nitrogen additions either in a soil deficient in plant-available phosphorus or one adequately supplied with indigenous available phosphorus. However, the total uptake of plant residue phosphorus by the test crop was significantly influenced by the concentration of phosphorus in the residue.

U. Ariz., Agr. Expt. Sta., Tucson, Ariz.

Scarsbrook, C. E. UREA-FORMALDEHYDE FERTILIZER AS A SOURCE OF NITROGEN FOR COTTON AND CORN. Soil Sci. Soc. Amer. Proc. 22: 442-445. 1958.

Three formulations of experimental 12-12-12 grade fertilizer, each containing a portion of the nitrogen as urea-formaldehyde, were compared with ammonium nitrate as sources of nitrogen for cotton and corn. The 12-12-12 used in 1955 contained 38% of the nitrogen as urea-formaldehyde with an availability index of 20; in 1956 two formulations were used with urea-formaldehyde percentages of 35 and 36 and availability indices of 49 and 57, respectively. Ammonium nitrate produced higher yields than equivalent rates of nitrogen from fertilizer containing urea-formaldehyde. Nitrogen contents of corn leaf samples and of grain were higher where ammonium nitrate was the source of nitrogen. The residual value of nitrogen on oat forage following corn was determined. Urea-formaldehyde with an availability index of 49 had the greatest residual effect. However, the residual effect from ammonium nitrate was greater than from the index-20 material.

Agr. Expt. Sta., Ala. Polytech. Inst., Auburn, Ala.

Stewart, B. A., and Eck, H. V. THE MOVEMENT OF SURFACE-APPLIED NITRATE INTO SOILS AT FIVE MOISTURE LEVELS. Soil Sci. Soc. Amer. Proc. 22: 260-262. 1958.

A laboratory study was conducted to determine the extent of movement of surface-applied nitrate into soils at five moisture levels.

Aliquots of Tillman cl soil were adjusted to the desired moisture levels. Ammonium nitrate was broadcast on the surface. The soil was incubated at constant temperature and moisture for 14 days. The soil was then sampled by horizontal sections and nitrate determinations were made.

Downward movement of nitrate progressed to a depth of 2 1/2 inches when the soil was at moisture equivalent, to 2 inches when the soil was at the 3- and 5-atm. percentages, and to 1 1/2 inches when the soil was at the 8- and 15-atm. percentages.

Nitrate movement was also studied under field conditions on three soil types. Statistical analysis shows that there was a significant movement of nitrate to a depth of 1 1/2 inches, but not below this depth.

Okla. Agr. Expt. Sta., Stillwater, Okla.

Parks, W. L., and Fisher, W. G., Jr. INFLUENCE OF SOIL TEMPERATURE AND NITROGEN ON RYEGRASS GROWTH AND CHEMICAL COMPOSITION. Soil Sci. Soc. Amer. Proc. 22: 257-259. 1958.

Annual ryegrass was grown under controlled conditions at different rates of nitrogen fertilization on Hermitage sil surface soil that was low in ammonia and nitrate nitrogen. Alternating periods of 16 hours of light and 8 hours of darkness were maintained in growth chambers set at 10°, 20°, and 30° C. The ryegrass responded to nitrogen fertilization up to the rate of 100 pounds per acre and the response was greatest at the 20° C. temperature. Nitrogen was more efficiently utilized by the ryegrass at the 20° and 30° C. temperature than at the 10° C. temperature. The uptake of potassium, calcium, magnesium, and phosphorus was retarded at the 10° C. temperature. Phosphorus uptake and yield of forage were directly related and the calcium content of the ryegrass increased as the temperature and rate of nitrogen increased.

U. Tenn. Agr. Expt. Sta., Knoxville, Tenn.

Abruna, F., Pearson, R. W., and Elkins, C. B. QUANTITATIVE EVALUATION OF SOIL REACTION AND BASE STATUS CHANGES RESULTING FROM FIELD APPLICATION OF RESIDUALLY ACID-FORMING NITROGEN FERTILIZERS. Soil Sci. Soc. Amer. Proc. 22: 539-542. 1958.

An evaluation was made of the changes in soil reaction and exchangeable base content of two Red-Yellow Podzolic soils (Cecil sl and Fajardo c) and one alluvial soil (Toa cl) resulting from high rates of application of ammonium nitrate and of ammonium sulfate.

Severe reductions in exchangeable base level and lowering of soil pH occurred within a year after beginning N applications. The undesirable effects occurred deep in the soil profile where corrections would be difficult, if not impossible, from a practical standpoint. Exchangeable K was lost from the soil faster than other bases at the higher rates of N. No indication of a subsoil zone of accumulation of bases leached out of upper horizons was observed. The measured losses of exchangeable bases were appreciably lower than calculated CaCO<sub>3</sub> equivalents of the residual acidity of the fertilizer except for the higher N rates on the Toa cl.

Charts and Graphs.

SWCRD, ARS, USDA, Rio Piedras, Puerto Rico.

Stevenson, F. J., Dhariwal, A. P. S., and Choudhri, M. B. FURTHER EVIDENCE FOR NATURALLY OCCURRING FIXED AMMONIUM IN SOILS. Soil Sci. 85: 42-46. 1958.

Confirmatory evidence was obtained in support of recent findings that soils contain considerable amounts of naturally occurring fixed ammonium. An Elliott sil soil where illite was the predominate clay mineral contained larger amounts of fixed ammonium than a Cisne sil soil where montmorillonite was the predominate clay mineral. Naturally occurring fixed ammonium appears to be present in most of the soils that are agriculturally important in the corn belt region of the United States.

A study of the chemical nature of humic acids extracted from the A<sub>1</sub>, B<sub>1</sub>, B<sub>3</sub>, and C horizons of Elliott sil showed that humic acid did not contribute to narrowing of the C/N ratio with depth in the profile. Humic acids extracted with pyrophosphate were chemically different from humic acids extracted with a NaOH, as indicated by a study of humic nitrogen.

The nitrogen obtained by using the Kjeldahl method for soils should not be reported as "organic nitrogen" except where fixed ammonium is known to be absent.

Ill. Agr. Expt. Sta., Urbana, Ill.

Tyler, K. B., and Broadbent, F. E. NITROGEN UPTAKE BY RYEGRASS FROM THREE TAGGED AMMONIUM FERTILIZERS. Soil Sci. Soc. Amer. Proc. 22: 231-234. 1958.

A comparison of the utilization of ammonium nitrogen from  $\text{NH}_4\text{OH}$ ,  $(\text{NH}_4)_2\text{SO}_4$ , and  $\text{NH}_4\text{NO}_3$  in two California soils was made in greenhouse pot tests. These fertilizers were applied at the rate of 200 pounds N per acre in each two applications, with  $\text{N}^{15}$  used to label the ammonium source of N in the first application. Ryegrass was seeded after the initial fertilizer application and four cuttings of grass were analyzed for total N and  $\text{N}^{15}$ . The second fertilizer application with untagged materials was made following the second cutting. After the fourth cutting, the soil was dried, sieved, and analyzed for total N and  $\text{N}^{15}$ .

Greatest yield of ryegrass and highest recovery of N from the tagged source were found where  $(\text{NH}_4)_2\text{SO}_4$  was applied. No real difference was observed in the percent recovery of N from  $\text{NH}_4\text{OH}$  and  $\text{NH}_4\text{NO}_3$ , but the yield of grass was somewhat higher with  $\text{NH}_4\text{NO}_3$ . Total N in the crop followed the same trend as the yield data. Considerable tagged nitrogen was immobilized soon after application as shown by relatively low crop recovery of added fertilizer in all but the  $(\text{NH}_4)_2\text{SO}_4$ -treated pots. Total recovery from the plant and soil varied from 83 to 97% of the tagged nitrogen applied. Exchange between inorganic and organic nitrogen was estimated in a laboratory incubation experiment.

U. Calif., Davis, Calif.

Allos, H. F., and Bartholomew, W. V. REPLACEMENT OF SYMBIOTIC FIXATION BY AVAILABLE NITROGEN. Soil Sci. 87:61-66. 1959.

The influence of increasing increments of available inorganic nitrogen on symbiotic nitrogen fixation was studied with a number of legumes. The plants were grown in gravel culture in the greenhouse and supplied at weekly intervals with varying amounts of tracer nitrogen. Subsequent analyses of the plant nitrogen permitted calculations of the nitrogen coming from the fertilizer and that arising from fixation.

All legumes responded in growth and in nitrogen uptake to the addition of inorganic nitrogen. In some instances the increases in growth resulting from fertilization caused increases in fixation of nitrogen. When the applied nitrogen exceeded that necessary for the growth increase, it tended to replace the fixation process.

Total fixation of nitrogen by the several legumes was closely related to the amount of growth.

Fixation processes never supplied sufficient nitrogen for maximum growth under the conditions of the experiments. Each specie exhibited an apparent capacity to supply by fixation only about one-half to three-fourths of the total nitrogen which could be used by the plant.

Amer. U. at Beirut, Lebanon.

Tyler, K. B., Broadbent, F. E., and Hill, G. N. LOW-TEMPERATURE EFFECTS ON NITRIFICATION IN FOUR CALIFORNIA SOILS. Soil Sci. 87:123-129. 1959.

From this investigation designed to provide information on the effect of low temperatures on nitrification rate in California soils (Hanford sl, Sacramento c, Salinas c, and Yolo l) several facts have emerged: (1) Although lowering of the temperature from  $75^\circ$  to  $45^\circ$  F. materially decreases the rate of nitrification process, at  $45^\circ$  F., which is considered a minimum average winter temperature in many California agricultural areas, nitrification still proceeds at a moderate rate. On the basis of these findings, the practice of fall nitrogen fertilization, using ammoniacal forms to prevent nitrogen loss by leaching, is questionable in climates where the soil does not freeze. (2) Inhibition of the nitrification process appears to be somewhat greater as a result of low temperatures



than does the process of ammonification of soil organic nitrogen. (3) Low temperature and alkaline soil reaction appear to favor nitrite accumulation from ammoniacal fertilizers even at low levels of addition. This finding suggests that the (Nitrobacter) group, which oxidizes nitrite to nitrate, are more sensitive to low temperature than the (Nitrosomonas) group responsible for the first step in nitrification; or that there is an interaction between temperature and free ammonia inhibition of (Nitrobacter). (4) Lowering of temperature produces no significant change in the comparative rates of nitrification between ammonium hydroxide and ammonium sulfate from those observed at 75°F. Ammonium hydroxide still nitrified more rapidly than ammonium sulfate in acid soils at 45°F., and the rates were often about the same in the calcareous soil. And (5), No minimum temperature for nitrification is suggested, since this apparently depends on the nature of the soil and ammonia concentration. A greatly reduced though still measurable rate of nitrification was observed in these soils as low as 37°F.

U. of Calif., Davis, Calif.

White, W. C., and Pesek, J. NATURE OF RESIDUAL NITROGEN IN IOWA SOILS.  
Soil Sci. Soc. Amer. Proc. 23: 39-42. 1959.

Increased quantities of soil nitrogen resulting from nitrogen applied to corn 1 year previously were characterized as to the form and location in soil. Under the experimental conditions the residual soil nitrogen appeared to be chiefly in the form of nitrates in the 6- to 21-inch layer. No appreciable quantities of residual ammonium nitrogen were found. Nitrification rate tests showed that effects of residual nitrogen on nitrifiable forms of nitrogen were negligible.

Quantities of residual nitrates in soil layers 0 to 6, 6 to 12, and 12 to 21 inches deep were related to the nitrogen yield of oats. As much as 90% of the total variations in nitrogen yield of oats were accounted for by the multiple regression of nitrogen yield on nitrate nitrogen found in the 3 soil layers. Simple linear regressions showed a high correlation between effects of residual nitrogen on nitrogen yield of oats and measured residual soil nitrates at the beginning of the oat season. Results of isotopic nitrogen measurements obtained from a greenhouse experiment provided additional evidence of residual nitrogen being present mainly as nitrates below the plow layer.

Iowa Agr. and Home Econ. Expt. Sta., Ames, Iowa.

Wagner, G. H., and Smith, G. E. NITROGEN LOSSES FROM SOILS FERTILIZED  
WITH DIFFERENT NITROGEN CARRIERS. Soil Sci. 85: 125-129. 1958.

The measured nitrogen losses ranged up to 85 percent of the treatment in laboratory investigations. It was established that losses involve volatilization of nitrogen gases other than elemental nitrogen. A small amount of nitrogen may be lost by volatilization as ammonia. Also, small losses may occur in the form of nitric oxide or nitrogen dioxide. Nitrous oxide, on the other hand, may account for a large part of the nitrogen loss under certain conditions which lead to denitrification.

The facts of this study emphasize the importance of considering soil conditions and forms of nitrogen applied if serious losses of nitrogen are to be prevented.

U. Mo., Columbia, Mo.

Legg, J. O., and Allison, F. E. RECOVERY OF  $N^{15}$ -TAGGED NITROGEN FROM  
AMMONIUM-FIXING SOILS. Soil Sci. Soc. Amer. Proc. 23: 131-134. 1959.

The uptake by Sudangrass of N applied to two ammonium-fixing subsoils Myersville and Miami at rates ranging from 0 to 400 pounds per acre was similar to the uptake from a nonfixing surface soil. N uptake from  $NaNO_3$  and banded  $(NH_4)_2SO_4$  mixed throughout the fixing soils, but the differences could not be attributed entirely to ammonium fixation. Where  $(NH_4)_2SO_4$  was mixed with the soil,  $A_e$  values calculated from the  $N^{15}$  data appeared constant for all N rates. A N-balance sheet prepared from analyses of soil and plant materials accounted for 93.6% of the  $N^{15}$ -tagged fertilizers as an average of all soils and treatments.

SWCRD, ARS, USDA, Beltsville, Md.

Pritchett, W. L., Eno, C. F., and Malik, M. N. THE NITROGEN STATUS OF THE MINERAL SOILS OF FLORIDA. Soil Sci. Soc. Amer. Proc. 23: 127-130. 1959.

Surface soil samples were collected at 240 sites from the major soil types and cultural practices in the state and analyzed for organic matter, total N and nitrate produced during 2 and 6 weeks of incubation. Correlation coefficients were determined among these properties after grouping the soils according to cultural practice and soil texture. The average organic matter and total N content of Florida mineral soils were 2.52 and 0.060%, respectively. Nitrate produced in 2 and 6 weeks of incubation averaged 21 and 42 ppm., respectively. All three of these constituents increased with increases in fineness of soil texture. Cultural practices also had an influence on these properties. In general, a highly significant relationship was found between total N and organic matter, and total N and nitrate production. However, a significant relationship between organic matter and nitrate production occurred only for certain of the cultural and textural groups with a higher degree of correlation at the end of 6 weeks than at the end of 2 weeks.

Fla. Agr. Expt. Sta., Gainesville, Fla.

Agronomists and Horticulturists. NITROGEN FOR GEORGIA CROPS. Ga. Agr. Expt. Sta., Tech. B.N.S. 17, 101 pp. 1959.

Nitrogen fertilization is one of the very important steps for good crop production in Georgia. Due to the warm humid climate and intensive cultivation nitrogen is one of the more limiting fertilizer elements.

Georgia farmers use the equivalent of 75 to 80 thousand tons of elemental nitrogen annually. This bulletin is concerned with results from the use of nitrogen on different crops with the objective in mind of utilizing nitrogen more efficiently.

This bulletin is the result of the efforts of agronomist and horticulturists that are mainly concerned with nitrogen use. It is the team approach to a problem.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Smith, C. M. RESIDUAL NITROGEN RESPONSE WITH WHEAT IN EASTERN OREGON. Tenth Annual Fert. Conf. Pacific Northwest, Proc. pp. 137-144. July 7-9, 1959.

In residual fertilizer studies with wheat in eastern Oregon, the magnitude of grain yield increase from residual nitrogen appeared to be related to the amount of response the first year and time of nitrogen application. The effect of first-year response on residual N response was most pronounced on the Walla Walla soil where highly efficient use of the fall-applied fertilizer was obtained the first year.

In nearly all instances, the response to the residual from spring-applied nitrogen was larger than from fall. The reason was not apparent although the longer contact with soil may have resulted in more of the nitrogen becoming unavailable for plants--either chemically or positionally.

The following tables show the results obtained from experiments on four different soils:

Table 1. The present value, per acre, of yield increases from the first and second crops of wheat after nitrogen fertilization of Walla Walla and Ritzville silt loam soils.\*

Lbs. N per A.	Walla Walla, 8 experiments				Ritzville, 9 experiments			
	Fall N		Spring N		Fall N		Spring N	
	1-yr.	2-yrs.	1-yr.	2-yrs.	1-yr.	2-yrs.	1-yr.	2-yrs.
	\$	\$	\$	\$	\$	\$	\$	\$
20	15	13	7	9	5	5	3	6
40	22	22	14	18	7	9	5	9
60	25	25	18	23	6	10	5	12
80	25	28	19	28	3	9	4	14

\*Present value = discounted income from yield increases minus fertilization costs. 1-yr. column - first crop; 2-yrs. column - first + residual crop.

Table 2. The present value, per acre, of yield increases or decreases from the first and second crops of wheat after nitrogen fertilization of Condon silt loam and Morrow silty clay loam.\*

Lbs. N per A.	Condon, 3 experiments				Morrow, 3 experiments			
	Fall N		Spring N		Fall N		Spring N	
	1-yr.	2-yrs.	1-yr.	2-yrs.	1-yr.	2-yrs.	1-yr.	2-yrs.
	\$	\$	\$	\$	\$	\$	\$	\$
20	6	9	6	10	-7	-4	-1	+2
40	8	15	5	13	-12	-8	-8	-3
60	6	12	4	15	-20	-14	-10	+1
80	1	10	6	22	-24	-15	-16	-5

\*Present value = discounted income from yield increases minus fertilization costs. 1-yr. column - first crop; 2-yrs. column - first + residual crop.

SWCRD, ARS, USDA, Pendleton, Oreg.

De Roo, H. C. NITROGEN SOURCES FOR CONNECTICUT TOBACCO. Conn. Agr. Expt. Sta. B. 623, 12 pp. 1959.

Fertilizer tests with different nitrogen sources were conducted on a cooperative basis on outdoor and shade tobacco farms throughout the Connecticut Valley. The object was to determine, under as many different conditions as possible, whether nitrogen fertilization of Connecticut tobacco can be put on a more economical basis. The tests of the fertilizer formulas showed that, at least under the conditions of 1958, meals are not necessary as a nitrogen source for the production of a tobacco crop of high yield and quality. Water-soluble nitrogen sources, such as ammonia, nitrate, and urea, when supplemented by sidedressing or by less soluble synthetics, such as urea-form, were practically as effective in the production of a crop as were the meals.

The difference in yield and quality between outdoor tobacco grown with meal and outdoor tobacco grown with one of the new, cheaper combinations of sources were insignificant in all tests.

Conn. Agr. Expt. Sta., New Haven, Conn.



Smika, D. E., and Smith, F. W. GERMINATION OF WHEAT AS AFFECTED BY BIURET CONTAMINATION IN UREA. Soil Sci. 84: 273-281. 1957.

A series of six trials to investigate both the damaging effects of biuret containing urea and the damaging effects of pure nitrogenous fertilizers were conducted. Commercial pelleted urea with varying percentages of biuret caused varying reductions in germination of wheat when the fertilizers were placed in intimate contact with the seed. The severity of damage caused by application of pelleted urea increased both as the rate of application and as the concentration of biuret increased. Under most conditions involved in this investigation the toxic effects of biuret upon germination were much more damaging than the germination interferences caused by application of an electrolyte (ammonium nitrate). Application of pure urea did not cause appreciable interference with germination under most circumstances. In all cases this nonelectrolyte was safer to apply in direct contact with the seed than was the electrolyte.

Kans. Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

Harpstead, M. I., and Brage, B. L. STORAGE OF SOIL SAMPLES AND ITS EFFECT UPON THE SUBSEQUENT ACCUMULATION OF NITRATE NITROGEN DURING CONTROLLED INCUBATION. Soil Sci. Soc. Amer. Proc. 22: 326-328. 1958.

Ten South Dakota soils were investigated to determine the effect of prolonged storage under air-dry conditions on the accumulation of nitrate nitrogen during subsequent laboratory incubation. Each soil was sieved and spread out in a drying cabinet where there was forced air circulation at room temperature. While the soils were still moist, as they occurred in the field, a sample of each soil was leached free of nitrate and incubated in a humid chamber for 14 days. Nitrate nitrogen which accumulated during the incubation period was determined. Similar incubations were made after soils had been stored at room temperature for 3, 6, 9, 18, 24, 34, and 50 weeks.

Results showed the nitrification rate of freshly-collected soil was high compared to that after air-drying and 3 weeks of storage prior to incubation. Subsequent incubations showed a progressive increase in the nitrification level. The precision of results among replicates improved with the length of storage. Prior to 18 weeks of storage the amount of nitrate nitrogen accumulated during incubations was not correlated with oat yield responses to nitrogen fertilization. Incubations made after 18 weeks of storage, however, yielded results which correlated with the response of oats to nitrogen fertilization.

U. Minn., St. Paul, Minn.

Nelson, C. E. LODGING OF FIELD CORN AS AFFECTED BY CULTIVATION, PLANT POPULATION, NITROGEN FERTILIZER, AND IRRIGATION TREATMENT. U.S.D.A., A.R.S. Prod. Res. Rpt. 16, 16 pp. 1958.

The effect of cultivation methods, plant populations, nitrogen fertilization, and irrigation treatments on lodging and yields of Wisconsin 641AA field corn free from root rot and corn borer conditions were studied.

Lodging data were taken in November in the conventional manner by counting broken and lodged stalks in the plots. Mechanical breakage of the standing stalk and the third internode made in September and the measurements of other plant characters were investigated as possible indices of the lodging potential.

Deep, close cultivation or shallow cultivation with or without hilling the soil did not affect lodging. Shallow cultivation without hilling decreased the yields of grain.

Nitrogen fertilization increased lodging. Early in the fall mechanical breakage of the diameter of the measurements of the third internode indicated the stalks from the nitrogen fertilization treatments to be more resistant to breakage. However, in the late fall this was more than overbalanced by increased ear weight and stalk and plant height as the stalk moisture decreased.

ARS, USDA, Inform. Div., Washington 25, D. C.

Boswell, F. C., Anderson, O. E., and Stacy, S. V. SOME EFFECTS OF IRRIGATION, NITROGEN AND PLANT POPULATION ON CORN. Ga. Agr. Expt. Sta., B. N. S. 60, 51 pp. 1959.

Field experiments with corn were conducted for three years on a sandy loam at Fort Valley in the Upper Coastal Plain, on a sandy clay loam at Experiment in the Piedmont Plateau, and on a silt loam at Calhoun in the Limestone Valley. Hybrids, Georgia 101 and Dixie 29, were grown at plant populations of 10,000, 15,000, and 20,000 plants per acre. 1955 tests received 96 pounds of  $P_2O_5$  and  $K_2O$ ; tests of succeeding years received 120 pounds. Nitrogen was applied at rates of 60, 120, and 240 pounds per acre. Half of the plots received irrigation when 25 percent of the plants wilted by mid-day. Results reported include grain yield, crude protein content, shelling percentage, and ear weight.

When moisture was a limiting factor during these stages, the average yield increase obtained from irrigation ranged from 15.5 to 58.2 percent.

Protein content decreased with irrigation, and with increasing plant population within a given rate of applied nitrogen. With the exception noted above, grain protein decreased as yield increased. However, the net effect was an increase in the acre yield of protein because the protein resulting from larger grain yields more than offset the decrease in protein percentage in the grain.

Those factors which acted to reduce ear weight usually also acted to increase ear counts.

At Fort Valley, yields tended to increase with increasing nitrogen supply and plant population two of three years when moisture was adequate. When moisture tended to be a limiting factor, yields were smaller and the effects of plant population and nitrogen were obscured. At any given level of nitrogen, ear counts increased as plant population increased, regardless of irrigation.

At Experiment, regardless of irrigation, yields increased as nitrogen supply increased from 60 to 120 pounds. However, the yields, and the increase due to nitrogen and population, were greater with than without irrigation. Ear counts increased with increasing plant population, and with increasing nitrogen up to 120 pounds of nitrogen per acre.

On the irrigated silty soil at Calhoun little increase in grain yield was obtained by using 120 or 240 pounds of nitrogen as compared to 60 pounds of nitrogen. Even though grain yield was not increased by increasing nitrogen applied, the data suggest that at least 90 pounds of nitrogen per acre should be applied, for at the 60 pounds nitrogen level more nitrogen was removed in the grain protein than was applied. This lack of yield response to higher levels of applied nitrogen probably was due in part to the initially high nitrogen content of the soil. The three populations, 10,000, 15,000, and 20,000 plants per acre, did not vary greatly in their influence on yields. However, without irrigation, 10,000 plants seemed to be the best plant population tested. Lack of moisture reduced ear counts on non-irrigated plots.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

### Salinity and Alkali Problems

Sayegh, A. H., Alban, L. A., and Petersen, R. G. A SAMPLING STUDY IN A SALINE AND ALKALI AREA. Soil Sci. Soc. Amer. Proc. 22: 252-254. 1958.

A study was made in the Baker Valley Area, Oregon, to determine by statistical analysis the variation in conductivity and exchangeable-sodium percentage (ESP) between soil mapping units and between locations within soil mapping units.

The variation between soil mapping units was significant at the 1% level for both conductivity and ESP. This would imply that there is a distinct difference between soil mapping units. The sample variation within locations and the location variation within soil mapping units were not large for soil conductivity but were quite large for ESP, particularly the individual sample variation. This indicates that for ESP the difference in the subsamples taken at one sampling location which make up a composite sample may vary as much or more than the samples taken over an area to represent a particular soil mapping unit.

It was shown that the variance of the mean may be reduced either by increasing the number of samples per location or by increasing the number of locations; the latter reducing the variance more rapidly. As the cost of moving from one location to another increases relative to the cost of processing a sample, the sampling rate per location should be increased.

Tech. Paper No. 1095, Oreg. Agr. Expt. Sta., Corvallis. Oreg.

Bernstein, L. SALT TOLERANCE OF VEGETABLE CROPS IN THE WEST. U.S.D.A., A.R.S. Agr. Inform. B. 205, 5 pp. 1959.

Salt tolerance is the degree to which a crop can produce a satisfactory yield on salty land.

Soil salinity, or saltiness, is a widespread condition in arid and semiarid areas and along lowlying seacoasts. Wherever irrigation is practiced, excessive amounts of soluble salts in the irrigation water or soil may cause a salinity hazard. The degree of salinity may be so low that it affects only the most sensitive crops or so high that few, if any, crops can be grown. Different crops vary widely in their tolerance to salinity. Therefore, information on salt tolerance is often valuable in deciding which crops to grow under existing conditions.

Salt affects the growth of vegetables primarily by decreasing the availability of water. In some cases, salinity also involves nutritional effects.

Because of the stunting of plants by salinity, most vegetables produced on saline soils are not of prime quality. Yields of such crops as tomatoes and peppers are reduced partly because of fewer fruits per plant but also because of a marked decrease in fruit size. Size generally declines and the proportion of culls usually increases as stunting becomes more severe. As all parts of the plant are stunted, roots, leafy or flowering heads, and other harvested plant parts all exhibit characteristic size decreases. Sweet corn is an exception in that ear size remains unaffected at moderate salinity levels, although the number of marketable ears per plant decreases appreciably.

Salinity, by checking the growth, may produce some favorable effects on some vegetable crops. It may increase the sugar content of some vegetables, especially carrots; but this gain in quality is more than offset by lowered yields. Cabbages from salty fields are generally more solid than those from nonsaline fields, but again, lowered yields offset this favorable effect.

Most vegetables are grown as row crops, and irrigation is generally by the furrow method. These practices cause a special problem during germination because salt may be carried into the top of the bed and become concentrated in the seed row. This has often been responsible for partial or complete failures of stand. Salt accumulation is much greater in the center of the bed than near the shoulders; therefore, double-row beds are less affected than single-row beds. In sloping seedbeds, the seed row is well below the zone of salt accumulation so that irrigation may actually remove salt from the seed row instead of bringing salt into it. Under saline conditions, modified planting and irrigation methods may make all the difference between success or failure.

Salinity is especially harmful to transplants. Because of unavoidable root pruning, transplants are already at a disadvantage in absorbing water. The limited water availability of saline soils is, therefore, particularly injurious. Whenever possible, avoid transplanting into saline soils. Transplanting into saline soil is especially injurious to warm-weather crops, such as sweetpotatoes.

ARS, USDA, Inform. Div., Washington 25, D. C.

Harding, R. B., Pratt, P. F., and Jones, W. W. CHANGES IN SALINITY, NITROGEN, AND SOIL REACTION IN A DIFFERENTIALLY FERTILIZED IRRIGATED SOIL. Soil Sci. 85: 177-184. 1958.

Salinity changes in the soil of an irrigated orange orchard during 28 years of differential fertilization are reported.

U. Calif., Citrus Expt. Sta., Riverside, Calif.



## Climatic Influences

Bathurst, N. O. . THE EFFECT OF LIGHT AND TEMPERATURE ON THE CHEMICAL COMPOSITION OF PASTURE PLANTS. New Zealand J. Agr. Res. 1: 540-552. 1958.

The effect of different levels of light and temperature on the chemical composition of some representative pasture grasses and legumes was investigated. Substances estimated included various nitrogenous constituents, sugars, ash, fructosan, and organic acids.

The effect of two levels of light and of temperature has been measured. The most striking changes were found in nitrate content, this being highest with low light and high temperature and lowest with high light and low temperature. White clover and short-rotation ryegrass showed some differences in behaviour when compared with other species.

An experiment using white clover at three different levels of light, other conditions being similar, showed a definite relationship between light intensity and chemical composition.

Finally, results are reported for three species grown in controlled environment cabinets at temperature levels varying from 45°F to 95°F.

Grasslands Div., Dept. Sci. and Indus. Res., Palmerston North, New Zealand.

## Mulching with plastics

Peters, D. B., and Russell, M. B. RELATIVE WATER LOSSES BY EVAPORATION AND TRANSPIRATION IN FIELD CORN. Soil Sci. Soc. Amer. Proc. 23: 170-173. 1959.

The separation of transpiration by corn and evaporation from the soil was experimentally accomplished, in the field, by covering the ground surface with polyethylene plastic. It was found that as much as 50% of total evapotranspiration could be accounted for by evaporation from the soil surface. Transpiration was found to be influenced in a minor way by plant population and soil moisture environment. Corn yields were depressed in only 1 year by elimination of summer rainfall.

SWCRD, ARS, USDA, Urbana, Ill.

Holekamp, E. R. COTTON EMERGENCE INCREASED WITH POLYETHYLENE COVERS. Tex. Agr. Expt. Sta. Prog. Rpt. 2113, 4 pp., illus. 1959.

The use of polyethylene covers to improve cotton emergence was investigated on the High Plains of Texas and at the Soils and Crop Unit at Pecos, Texas, during the spring of 1959.

Clear polyethylene covers were used with several planting procedures at each location to determine the effect on seedlings and the final amount of emergence.

Fifty-seven percent emergence of cottonseed was obtained in 5 to 7 days, while the emergence was only 7 percent for uncovered rows.

The polyethylene covers must be removed when emergence begins.

The stand of cotton in rows that had been covered remained higher 3 weeks after planting at three out of four locations observed.

Tex. Agr. Expt. Sta., Lubbock, Tex.

Harrold, L. L., Peters, D. B., Dreibelbis, F. R., and McGuinness, J. L. TRAN- SPIRATION EVALUATION OF CORN GROWN ON A PLASTIC-COVERED LYSIMETER. Soil Sci. Soc. Amer. Proc. 23: 174-178. 1959.

Corn grown on plastic-covered monolith lysimeters at Coshocton showed that a very good crop was produced using only the water stored in the soil. A yield of 125 bushels per acre was obtained by using only 8.5 inches of water from the soil. From June 6 to September 9 when the cover was in place, estimated evaporation and measured transpiration amounts were an approximate 45:55 ratio. For the entire growing season, May

1 to September 9, it was estimated that the evapotranspiration would be composed of 56% evaporation and 44% transpiration. Estimated soil moisture evaporation was compared with actual pan evaporation. The ratio of soil to pan evaporation was found to vary from nearly 1 when the soil was moist and the cover scanty to a very small figure when the soil was dry and with maximum canopy shading.

Water-use efficiency was greatly increased by use of the plastic cover because loss of water by evaporation was eliminated. The above average temperatures and increase of apparent condensation on the plastic-covered lysimeter are discussed.

Stopping evaporation while permitting normal infiltration amounts resulted in increased percolation of 2.19 inches during the corn season. Residual effect on percolation noted during the normal recharge season that followed was only 0.33 inch.

SWCRD, ARS, USDA, Coshocton, Ohio

Army, T. J., and Hudspeth, E. G., Jr. BETTER GRASS ESTABLISHMENT WITH PLASTIC COVERS. Tex. Agr. Prog. 5(4): 20, 22-23. 1959.

Soil moisture studies conducted at the Southwestern Great Plains Field Station at Bushland show that the top 1/2-inch of Pullman sil profile usually dries rapidly. With the high evaporative condition found in the Texas Panhandle, the seed zone (0 to 1/2-inch depth) of the soil often decreases in moisture content from field capacity to below the wilting point in less than 24 hours. Surface crusting accompanies the rapid drying. The extremely rapid drying of the seed zone, in addition to surface crusting, probably is one of the major causes of most grass seeding failures.

Plant residues on the soil surface will improve moisture conditions temporarily for grass seeding emergence. However, from field observations and previous work, it appears that artificial methods which would reduce drastically the moisture loss from the seed zone would have to be devised for successful grass seeding. Controlled experiments using polyethylene plastic sheets were, therefore, initiated.

Blackwell switchgrass (Panicum virgatum) was sown on Pullman cl. Seed was placed approximately 1/2-inch below the soil surface. Two rows of seed with 40 seeds in each row were planted in each treatment. The seed were covered with dry soil.

In all tests, moisture moved from lower depths into the seed zone portion of the profile where plastic covers were used. At the completion of each trial, moisture content in the 0 to 1/2-inch portion of the profile under the plastic covers was approximately field capacity. Moisture content in the seed zone of the uncovered plots was considerably below the wilting point. Severe surface crusting always was evident on the uncovered plots.

Clear or translucent plastic coverings are recommended for improving grass establishment on seedbeds of limited areas where plant cover is urgently needed. Earth dams, military installations, waterways, terrace channels and ridges are some examples where sheets of clear or translucent polyethylene plastic could be used to great advantage. Large sheets of clear plastic have been used successfully in lawn establishment in Amarillo. For field use, if possible, ample supplies of water should be applied to the seeded area prior to using the plastic cover. No additional moisture application should be required until the grass has emerged and the plastic removed. The plastic sheets or strips should be well secured to prevent wind whipping and tearing.

SWCRD, ARS, USDA and Tex. Agr. Expt. Sta., College Station, Tex.

## PLANT MANAGEMENT

### Pasture and Haylands

Ehrenreich, J. H. EFFECT OF BURNING AND CLIPPING ON GROWTH OF NATIVE PRAIRIE IN IOWA. J. Range Mangt. 12:133-137. 1959.

Effects of burning and clipping were studied on growth of some dominant and principal subdominant grasses and forbs on a mesic native prairie in Northeastern Iowa on Carrington sil. Burning about the first of March had no apparent adverse effects on native vegetation, but did inhibit growth of Kentucky bluegrass. Prairie plants began growth 2

to 3 weeks earlier on burned areas, and produced more and taller flowerstocks than on unburned areas. Earlier growth and greater seedstock production probably results from higher soil temperatures in early spring where litter has been removed by burning. Although there were more flowerstalks on burned areas, there was no significant difference in total yield due to burning.

Clipping four times during the growing season did more harm to plants than clipping only once at the end of the growing season. A 79 percent reduction in yield was obtained from 2 consecutive years of frequent clipping compared to only 16 percent from 2 consecutive years of clipping at the end of the season.

Clipping at the end of the growing season appears to be the best way to get maximum sustained yields.

Range Conservationist, Central States Forest Expt. Sta., FS, USDA, Columbia, Mo.

Craigmiles, J. P., Elrod, J. M., and Luttrell, E. S. THE INFLUENCE OF METHOD AND RATE OF SEEDING AND SEED TREATMENT ON STANDS AND YIELDS OF SUDAN GRASS AND MILLET. Ga. Agr. Expt. Sta. Mimeo. Ser. N. S. 47, 7 pp. 1959.

Four years of testing the effect of method and rate of seeding on Tift Sudan grass, Starr millet, and browntop millet forage production were conducted. The influence of chemical seed treatment of these same three species at five locations was also studied. Conclusions and recommendations based on results obtained from these studies are as follows:

1. It is recommended that Sudan grass and millet be broadcast or drilled where weeds are not a problem.
2. Where weeds are prevalent, planting in narrow rows so that weeds can be controlled by cultivation is recommended.
3. The present recommended rates of seeding millet and Sudan grass at 10 to 15 pounds of seed per acre in rows and 20 to 25 pounds drilled or broadcast are adequate for maximum forage production. These rates are for seed of high germination.
4. Seed treatment generally is of little benefit in increasing stands, although it may be recommended if seed of poor quality must be planted. The use of good quality, clean seed is more important.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Ukkelberg, H. G., Southwell, B. L. and Stephens, J. L. ADAPTABILITY AND PRODUCTION OF VARIOUS PASTURE GRASSES IN COMBINATION WITH CLOVER ON BLADEN AND ASSOCIATED SOILS. Ga. Agr. Expt. Sta. Mimeo Ser. N. S. 58, 10 pp. 1958.

Trials with five pasture grasses with Crimson and Ladino clovers have been in progress for four years on Bladen and associated soils. Four summer-growing grasses, Coastal Bermuda, Pensacola Bahia, Argentine Bahia, and Dallis, and one winter grass, Kentucky 31 tall fescue, were used.

Production and adaptability were measured by grazing with young steers and by clipping caged areas. The results obtained show that Coastal Bermuda produced the highest gain in liveweight and the largest amount of forage, with Pensacola Bahia second. Lower gains and forage yields were obtained from Argentine Bahia and Dallis grass. Kentucky 31 tall fescue produced comparatively low gains per acre and low forage yields.

Daily gains per steer from the summer grasses were not significantly different, indicating a uniformity in quality of the forage produced. High correlations between forage yields and beef gains per acre were obtained. Differences in beef gains per acre, therefore, can be attributed primarily to the differences in forage yields of the various grasses.

These trials indicate that Coastal Bermuda and Pensacola Bahia are adapted to Bladen and associated soils. Both of these grasses were superior to Argentine Bahia and Dallis grass under the conditions of the experiment.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.



Bregger, T., and Kidder, R. W. GROWING SUGARCANE FOR FORAGE. Fla. Agr. Expt. Sta. C. S-117, 12 pp. 1959.

Sugarcane is a preferred cattle forage because it produces a higher yield per acre of total digestible nutrients than any other crop available and because the harvesting season coincides with the period of the year when perennial pastures grow slowly or are damaged by frost.

Considerable research was completed at the Florida Agricultural Experiment Station a few years ago on the use of sugarcane for feed. These records are reviewed.

Cultural practices, varieties, methods of propagation and other essentials for growing sugarcane are presented, so that sugarcane can be evaluated as a source of supplementary forage for winter feeding of cattle in Florida.

U. of Fla. Agr. Expt. Sta., Gainesville, Fla.

Baird, D. M., and Sell, O. E. SPRING LAMB PRODUCTION PRACTICES WITH WINTER TEMPORARY PASTURES IN GEORGIA. Ga. Agr. Expt. Sta. B. S. 63, 37 pp. 1959.

Spring lamb grazing, feeding, and management trials have been conducted on winter temporary pasture over a six-year period. The pasture mixture consisted of mixtures of oats, rye, crimson clover, and ryegrass usually seeded during late September or early October and well fertilized. Under these conditions of an abundant supply of high quality forage the following conclusions from the tests were made.

1. Winter temporary pasture apparently stimulated ewes' milk production above that obtained with a full barn ration. This stimulation was evident through increased lamb gains when ewes were provided two hours or more grazing daily.
2. When it was necessary to ration this pasture, it was more valuable when grazed directly by the lambs than when grazed by the ewes.
3. Supplemental barn feeding of hay and grain to ewes grazing an adequate supply of this forage did not improve lamb performance and increased cost of production.
4. Crop feeding of lambs when an adequate forage supply was available did not improve the lambs' growth rate or slaughter grade.
5. Shelled corn as the only creep was consumed with more relish than creep feed mixtures.
6. Lambs can be successfully weaned at earlier than market weights provided there is an adequate supply of high quality winter temporary pasture.
7. Under the conditions of these tests, lambs weaned at 45 to 60 pounds can be expected to reach market weight just as quickly as those which remain with their dams.
8. Creep consumption was not stimulated by early weaning. Also, the lamb performance was not improved by creep feeding the early weaned lambs.
9. The majority of the lambs in these tests graded Prime and Choice at market time. There was no lowering of grade as a result of early weaning and grades were not improved by creep feeding the early weaned lambs.
10. Early weaning of lambs offers several important advantages to the producer, but only if an adequate supply of quality forage is available for the early weaned lambs. Some of these advantages would include improved pasture sanitation, easier lamb management practices, reduced requirements of high quality pasture, possibly earlier ewe breeding, less crowding in barns, and greater production economy.
11. Winter temporary pasture is probably the most productive pasture available to the lamb producers in Georgia. For the economical production of high quality market lambs there should be an abundant supply of winter temporary forage from birth to market weight.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Chin, N. L., Raye, H. E., Caldwell, A. C. and Hustrulid, A. EFFECT OF PHOSPHATE SOURCE, LIME, AND TIME OF PHOSPHATE APPLICATION ON ABSORPTION OF APPLIED PHOSPHORUS BY PLANTS. Soil Sci. Soc. Amer. Proc. 23: 299-302, 1959.

Effects of P source, rate of liming, and time of contact between fertilizer and soil on the availability and uptake by plants of phosphatic fertilizers applied to several Minnesota soils have been studied in greenhouse experiments.

Monocalcium phosphate resulted in significantly higher yields and lower P contents of wheat than dicalcium phosphate, and was more available to both wheat and alfalfa.

Alfalfa yields generally increased with an increase in the rate of liming. Liming had no apparent effect on the total P content of wheat or alfalfa, but the uptake by alfalfa of P from applied monocalcium phosphate was increased by the 4-ton per acre rate of lime application. With both phosphate sources, alfalfa yields were highest on the alkaline soils, and lowest on an acid soil.

Time of phosphate application had no consistent effect on growth rate or dry matter production of oats, although yield responses to phosphate fertilization were obtained on four soils. Phosphorus content of oats was generally increased when fertilizer was applied ahead of the planting date. Availability of applied phosphate tended to decrease on two high pH soils when fertilizer was applied 20 days or more ahead of planting.

Paper No. 3954 Sci. J. Ser. Minn. Agr. Expt. Sta., St. Paul, Minn.

Bouldin, D. R. and Sample, E. C. LABORATORY AND GREENHOUSE STUDIES WITH MONOCALCIUM, MONOAMMONIUM, AND DIAMMONIUM PHOSPHATES. Soil Sci. Soc. Amer. Proc. 23: 338-342. 1959.

Pellets of monocalcium phosphate monohydrate (MCP), monoammonium phosphate (MAP), and diammonium phosphate (DP) containing 15 mg. of P were placed on the surface of moist Hartsells fsl (pH 5.2) and Webster sicl (pH 8.3). After 3 and 5 weeks the distribution and solubility of the soil-fertilizer P reaction products were measured with soil samples taken at various radial distances from the center of the pellets. Plant response to pellets of fertilizer was measured in greenhouse experiments.

With both soils, distribution of total fertilizer P did not change appreciably in the interval between sampling periods. Fertilizer P moved about 2.5 and 1.5 cm. from the center of the pellets with the Hartsells and Webster soils, respectively. Differences among sources in the same soil were relatively small.

With the Hartsells soil, 6.5 and 11% of the fertilizer P was soluble in 1:15 soil-water extracts with the MCP and DP sources, respectively; with the Webster soil the corresponding figures were 5.2 and 1.0%. The measurements of water-soluble P in the laboratory explained 85% of the variation in plant uptake of P with the different fertilizers in greenhouse experiments. In laboratory and greenhouse experiments DP was superior to MCP in the Hartsells soil, while MCP was much superior to DP in the Webster soil. MAP was intermediate in behavior between the 2 other sources with the Hartsells Soil, but was roughly equivalent to MCP with the Webster soil.

Div. of Agr. Relat., TVA, Wilson Dam, Ala.

Fisher, F. L., and Caldwell, A. G. THE EFFECTS OF CONTINUED USE OF HEAVY RATES OF FERTILIZERS ON FORAGE PRODUCTION AND QUALITY OF COASTAL BERMUDAGRASS. Agron. J. 51: 99-102. 1959.

Coastal Bermudagrass produced an average (1954-57) of 13.0 tons of 13% protein hay per acre when fertilized with 1000 pounds of nitrogen annually. Lime, phosphorus and potassium were supplied as needed. Without nitrogen 2.7 tons of 8% protein hay was produced. Four hundred pounds of N annually produced 8.6 tons of 12% protein hay. Plant and soil analyses suggested that a 5-1-2 ratio of N,  $P_2O_5$ , and  $K_2O$  should be applied to obtain high production. Liming was necessary to control soil acidity.

Tex. Agr. Expt. Sta., College Station, Tex.

Mitchell, W. H., and Cotnoir, L. J., Jr. THE FERTILITY REQUIREMENTS OF LADINO CLOVER AND ORCHARD GRASS. Del. Agr. Expt. Sta. B. 325 (Tech.), 24 pp. 1959.

Forty-two different fertilizer treatments were used annually at two locations on a mixture of ladino clover and orchard grass. At the end of the second year at Newark and third year at Georgetown the clover had entirely disappeared which shows that in this study fertilization was probably not the controlling factor in the survival of ladino clover.

The Norfolk ls, considered a droughty soil, produced as well as the heavier Sassafras soil. Whereas mid-summer production was not as high, earlier growth in the spring and later growth in the fall tended to compensate for this.

At Newark, the  $P_1 K_1$  treatment produced as much forage as higher levels of phosphorus and potash which indicates that this treatment is adequate on this type of soil for high production of ladino clover and orchard grass. This is particularly true if the main objective is to encourage the growth of the clover.

At Newark and Georgetown the use of nitrogen, phosphorus and potash in a 1-1-1 ratio resulted in the highest yields.

When nitrogen was not used at Georgetown yield increases did not result from the use of more than 100 pounds of  $P_2 O_5$  but small increases were noted with the use of up to 400 pounds of  $K_2 O$ . This suggests the use of an 0-1-3 fertilizer ratio for mixtures consisting primarily of Ladino clover.

At both locations the use of phosphorus and potash, without nitrogen, resulted in the best seasonal distribution of growth. The highest levels of clover were also associated with this treatment.

The use of nitrogen fertilizer consistently resulted in larger yields with lesser amounts of clover, the most significant yield increases occurring during the spring months.

Split applications of phosphorus and potash fertilizers did not result in improved distribution or increased total yields.

Split applications of nitrogen-containing fertilizers improved the seasonal distribution of forage growth but at the high nitrogen level the total yield was significantly decreased over a three-year period. The small improvement in seasonal distribution did not appear to justify the split applications.

Nitrogen-containing treatments consistently produced a larger amount of total crude protein than the no-nitrogen treatments. This occurred even though at the high nitrogen levels the growth was essentially all orchard grass.

Under the influence of high levels of spring-applied nitrogen there was an increase in the succulence of orchard grass during the spring months followed by a greater than normal decrease in succulence as the season progressed. In so much as succulence is related to palatability, high-nitrogen treatments may be associated with a decrease in acceptance of orchard grass during the latter part of the grazing season. On the other hand high succulence may limit dry matter intake.

U. Del. Agr. Expt. Sta., Newark, Del.

Engibous, J. C., Friedmann, W. J., Jr., and Gillis, M. B. YIELD AND QUALITY OF PANGOLAGRASS AND BAHIAGRASS AS AFFECTED BY RATE AND FREQUENCY OF FERTILIZATION. Soil Sci. Soc. Amer. Proc., 22: 423-425. 1958.

Field studies were carried out to determine the effect of rate and frequency of fertilization, primarily nitrogen, on the total production of forage and crude protein of Pensacola Bahiagrass and Pangolagrass under central Florida conditions, and to estimate their persistence under conditions of high fertility.

The optimum nitrogen fertilization rate for Bahiagrass over the 5-year period was 240 pounds per acre applied in 2 applications per year. Bahiagrass was damaged by single applications of greater than 240 pounds of nitrogen. The data showed that 200 pounds each of  $P_2 O_5$  and  $K_2 O$  represented more than adequate levels of these nutrients. There was no benefit from split applications of phosphorus and potassium, which were applied at 200 pounds (oxide basis) per year.



Pangolagrass responded to higher levels of nitrogen application--the optimum level was 320 pounds of nitrogen per acre per year. This grass can tolerate single applications of nitrogen up to 480 pounds per acre. In terms of forage or protein production, there was no advantage in split applications of nitrogen.

International Minerals and Chem. Corp., Skokie, Ill.

Stephens, J. L. and Marchant, W. H. INFLUENCE OF RATES OF NITROGEN ON COASTAL BERMUDAGRASS. Ga. Agr. Expt. Sta. C.N.S. 13, 44 pp. 1959.

Ten years observation of Coastal Bermudagrass sod under various fertilizer treatments are reported. 50 pounds of nitrogen per acre is not enough to maintain a sod sufficiently dense to control all weeds. Enough weeds such as (*Juncus* sp.,) groundsell, and pigweed came into these pastures to necessitate extra mowings. It appears that under conditions similar to those of this test about 100 pounds of nitrogen will be necessary to maintain a dense sod. Even on the pastures receiving 100 pounds of nitrogen, some weeds came in but were never serious.

Crimson clover and lupine are not always dependable when interplanted with Coastal Bermudagrass. Sufficient fall moisture and short grass sod are necessary for establishing and obtaining a good clover growth. Lack of sufficient moisture often interferes with the establishment of good stands of legumes. Lupine in a sod is cold damaged and killed at higher temperatures than that planted on a prepared seed bed.

Burning in late February does not appear to harm Coastal Bermudagrass, and such late burning tends to control spring weeds such as pepper weed, primrose, spurge, etc. It is recognized that burning destroys organic matter; however, late-winter burning gives less chance for minerals in the ash to be leached out before being taken up by the grass roots during spring growth. Burning removes dead, unpalatable litter and helps control insects and diseases. In the winter of 1956 all pastures were burned except those containing clover and lupine. During the following summer a serious outbreak of spittle bugs occurred. These bugs appeared to spread from the unburned grass area, suggesting that an occasional burning may be of value in controlling such pests.

Manure droppings can become rather serious in contaminating a pasture where stocking rate is as high as 3 to 4 animals per acre, as was the case during part of each grazing season on pastures receiving the higher levels of fertilization.

Whether a farmer fertilizes at the minimum rate to maintain satisfactory weed control (about 100 pounds of nitrogen plus phosphate and potassium to give a 4-1-2 ratio) or at a higher rate to secure more nearly maximum forage production, will depend on a number of factors related to the individual farm operation. In this test 100 pounds of nitrogen per acre produced, over the 7-year period, an average of 425 pounds of live-weight beef gain. Where 200 pounds of nitrogen were used per acre, the comparable gains were 620 pounds.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Stephens, J. L. and Marchant, W. H. THE INFLUENCE OF IRRIGATION, RATES OF NITROGEN, AND INTERPLANTED CROPS ON FORAGE PRODUCTION OF COASTAL BERMUDAGRASS. Ga. Agr. Expt. Sta. N.S. 12, 15 pp. 1958.

Coastal Bermudagrass was interplanted with five legume and five non-legume winter-growing crops, with and without irrigation. Non-legume crops were topdressed with 100-, 200-, 300-, and 400-pound rates of nitrogen. Legume crops were not nitrogen topdressed.

Irrigation was applied so as to have a minimum of one inch of water per week.

Legume winter crops responded to irrigation more than non-legume winter interplanted crops. Crimson clover benefited most by irrigation, probably lowering temperature, hastening germination, and saving many small clover seedling plants which often come up and die during fall droughts. Abruzzi rye and oats showed least benefit by irrigation; indeed, several plots were adversely affected.

Heavy nitrogen topdressing of Coastal Bermudagrass appears to be antagonistic to the growth of interplanted legumes. Better survival and stand of plants were produced on low nitrogen plots. The pH was lower on heavy topdressed plots. All fertilizer was applied in a 4-1-2 ratio.

The Coastal Bermudagrass following winter-interplanted crops showed that the interplanted crops retarded Bermudagrass growth in the spring. Rye grass followed by Rescue grass adversely affected Bermuda growth to the greatest extent.

Coastal Bermudagrass was benefited in every instance by irrigation. The increase in yield of forage varied from a low of 1,043 pounds to a high of 4,751 pounds increase per acre due to irrigation. The average increase of all 480 plots was 3,002 pounds per acre.

Coastal Bermudagrass forage yields as influenced by rates of nitrogen showed considerable variation. Per-acre yields from non-irrigated plots varied from a low of 9,189 pounds of forage when topdressed with 200 pounds of nitrogen to a high of 13,192 with 800 pounds of nitrogen topdressing. When irrigated, the low yield was 10,848 pounds of forage topdressed with 200 pounds of nitrogen and the highest yield was 17,797 pounds per acre when topdressed with 800 pounds nitrogen.

While lowest yields were with the 200-pound rates of topdressing and the highest were with the 800-pound rates, diminishing returns appear to occur above the 400-pound rate of topdressing when irrigated.

It is questionable whether or not it is profitable to use much more than a 200-pound rate of nitrogen topdressing without irrigation.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Yamaguchi, S., and Crafts, A. S. COMPARATIVE STUDIES WITH LABELED HERBICIDES ON WOODY PLANTS. *Hilgardia* 29 (4): 171-204. 1959.

Large areas of range land, partly or almost completely covered with woody plants, constitute one of the greatest opportunities for use of herbicides. There are around 100 million acres of such land in the southwestern United States, and the southeastern and eastern states must have at least an equal area. Add to this a fair portion of the continents of Africa, Asia, South America, and Australia and it seems apparent that the control of brush and woody plants constitutes one of the major remaining frontiers for increasing agricultural production.

Relative mobility of 2,4-D, 2,4,5-T, ATA, MH, urea, and monuron was tested over a period of a year in the trunks of manzanita, toyon, and buckeye trees. From spot applications to the active phloem and the peak of downward movement came at the time of full development of the season's flush of growth in all three species. The other compounds were more generally carried away by the transpiration stream.

The phenoxyacetic acids were equally strongly absorbed both by the inner bark tissue and by the outer wood tissue of all three species regardless of whether they were translocated by the phloem or by the xylem. ATA was very strongly absorbed by xylem and lightly by the inner bark tissue of all three species regardless of whether it was transported by phloem or xylem. The translocation characteristics and mobility of the compounds were relatively consistent from species to species--however, manzanita was a better phloem translocator in general than buckeye; monuron was most mobile in manzanita; MH and urea most mobile in toyon tree trunks; and ATA in tip branches and in seedling plants of toyon.

Translocation of herbicides in the phloem can occur independently of the xylem. Downward movement in the tree trunk was in the phloem and upward movement was in the xylem.

Calif. Expt. Sta., U. Calif., Berkeley, California.

Edmond, D. B. SOME EFFECTS OF MCPB ON ESTABLISHING PASTURES. *New Zealand J. Agr. Res.* 1: 281-289. 1958.

MCPB (sodium salt) was sprayed on four newly sown pastures of short-rotation ryegrass and clover in autumn 1956, and a study was made of effects of time and rate of application on plant numbers and growth form.

In only two situations were white clover numbers reduced by 2 lb and 3 lb acid equivalent MCPB/acre, while red clover numbers were reduced by one 3 lb application. These reductions may have been due in part to the action of MCPB products in the soil.

All treatments reduced weeds, seedling docks (Rumex crispus L. and Rumex obtusifolius L.) in the 2-4 leaf stage being killed by 1 lb MCPB, but mature docks required 3 lb MCPB.

Establishing pasture of short-rotation ryegrass and clover could be sprayed with 1 lb acid equivalent MCPB/acre, without significant effect on white or red clovers, provided the soil was covered by foliage.

Grasslands Div. Dept. of Sci. and Indus. Res., Palmerston North, New Zealand

Animal Disease and Parasite Research Division. 16 PLANTS POISONOUS TO LIVESTOCK IN THE WESTERN STATES. U.S.D.A., Farm. B. 2106, 49 pp. 1958.

This Farmers' Bulletin illustrates and describes 16 plants poisonous to livestock in the Western States.

Where the plant grows; how it affects livestock; and how to reduce livestock losses are described for the following plants: Arrowgrass, Bracken Fern, Chokecherry, Copperweed, Death Camas, Greasewood, Halogeton, Horsebrush, Larkspur, Locoweed, Lupine, Milkweed, Oak Brush, Rubberweed, Sneezeweed and Water Hemlock.

ARS, USDA, Inform. Div., Washington, 25, D. C.

### Rangelands

Hull, A. C., Jr., Hervey, D. F., Doran, C. W., and McGinnies, W. J. SEEDING COLORADO RANGE LANDS. Colo. Agr. Expt. Sta. B. 498 S, 46 pp. 1958.

Information to guide the seeding of Colorado rangelands is reviewed.

Colorado varies greatly in elevation, topography, vegetation, soil and climate. Throughout the state are mountains, valleys, foothills, and plains which offer good seeding possibilities. As land areas are often recognized on the basis of vegetation, this section describes each major vegetation type and prescribes species and methods for seeding the following: shortgrass plains and sandhills, salt desert shrub, sagebrush, pinyon-juniper, oakbrush or mountain brush, ponderosa pine, aspen and spruce-fir. Under each type are recommendations for methods of seedbed preparation, seeding methods, season of seeding, and species.

Colo. State U. Expt. Sta., Fort Collins, Colo.

Marquiss, R., and Lang, R. VEGETATIONAL COMPOSITION AND GROUND COVER OF TWO NATURAL RELICT AREAS AND THEIR ASSOCIATED GRAZED AREAS IN THE RED DESERT OF WYOMING. J. Range Mangt. 12:104-109. 1959.

The Red desert of Wyoming is a valuable resource because it furnishes winter grazing for a high percentage of the state's sheep. Consequently proper grazing management of this and other winter range areas is a problem continually confronting the range manager.

Black Rock Butte and Pilot Butte in Sweetwater County, Wyoming, were studied as true natural relict areas to compare vegetational composition and ground cover with that of grazed land of similar rangesite characteristics surrounding these buttes.

Grazing has apparently caused a shift in vegetational composition on the shallow soil sites of Sweetwater County, Wyoming, as evidence by the greater number of forb species present on grazed areas, greater percentage of ground cover made up of shrubs, and smaller amounts of grass when compared with closely associated relicts.

The use of relict areas as a basis for judging grazed range lands is a common practice. However, this study shows a wide variation in the vegetational composition and ground cover between relicts of similar shallow soil sites separated by approximately 50 miles. This fact emphasizes the importance of using many relicts or protected areas as a basis for judging the condition of grazed lands.

Ground-cover fluctuations on both relict and grazed areas were high among years. Fluctuations in this factor were greater on the grazed areas than on the relicts for different years. These ground-cover changes among years may be largely attributed to the



shrubby vegetation and primarily to big sagebrush. However, ground cover of forbs also varied considerably on some of the grazed plots.

One shrub, three grasses, one sedge, and thirteen forb species occurred on plots of the grazed areas, but were not found on the relict plots. Two forb species occurred on the relicts but not on the associated grazed land.

Soil samples analyzed from each of the relict areas and from the grazed areas varied only slightly between the two locations.

Under the conditions of this study it must be concluded that big sagebrush and needle-and-thread are increasers, while winterfat is a decreaser under grazing. The reaction of other species to grazing pressure was not sufficiently definite for accurate classification as increasers or decreasers.

Col. Agr., U. Wyo., Laramie, Wyo.

Greenwell, S. THE CHANGING PICTURE IN HAWAIIAN RANGE MANAGEMENT.  
J. Range Mangt. 12: 99-103. 1959.

Cattle ranching is changing in Hawaii as it is all over the world. From native or wild cattle, poor grass, inadequate water supplies, and limited management, the cattle industry is becoming a highly specialized business. For example, on Kealakekua ranch, here are a few changes: native low-producing grasses, many acres of jungle, a little water, and almost wild cattle, demanding 10 to 15 acres per animal-month of grazing, to well-developed, fast-gaining long 2-year olds, grazing on improved pastures carrying 1 animal per acre-month for a 5 or 6 month period, and 2 1/2 big steers per month for a like period on introduced grass and legume paddocks. Water is pumped and stored at 400 to 800 pounds pressure in stages 6000 feet up Mauna Loa's sides; a weed, shrub and tree eradication program is carried out; new bulls with fast-gaining ancestral histories were obtained; and rotated and deferred grazing programs are carried out.

The jeep, truck, tractor, and jackhammer are fast replacing the donkey, horse, pick and shovel.

This article describes the early history of cattle ranching and how cattle ranching has been improved by modern methods in Hawaii.

Rancher, Kealakekua, Hawaii.

## Plant Materials

Miller, W. J., Beaty, E. R., and Underwood, L. M. A COMPARISON OF TIFT SUDAN AND STARR MILLET FOR DAIRY COWS BY SEVERAL TECHNIQUES. Ga. Agr. Expt. Sta. Tech. B.N.S. 16, 19 pp. 1958.

Tift and Starr were compared as temporary summer pasture crops in 1954 and 1955.

Fat corrected milk (FCM) production, fat percent in milk, FCM persistency, weight changes, digestibility, and forage consumption were measured with lactating dairy cows. In 1954 the cows were rotationally grazed in a double reversal design using three week periods, while in 1955 a single reversal pattern with a four week period was used. In both cases individual paddocks were grazed one week of each period with the remaining time allowed for regrowth.

Total digestible nutrients (TDN) yields per acre were measured by the animal requirement and cage clipping method.

In 1954 none of the differences between the Tift and Starr was statistically significant. In 1955 the fat percent of milk of cows grazing Starr was significantly lower. The difference in butter fat test was sufficient to result in a similar significant difference in FCM production and to result in a change in FCM persistency of considerable practical importance.

In 1955, as measured by the animal method, the Starr yielded highly significantly more than the Tift. There were no other significant differences in TDN yields between the two species as measured by either the cage clipping method or the animal method. The cage clipping method produced relatively more favorable results in both years for the Starr as compared to the Tift. The cage clipping method measured forage yields 28

percent higher than the animal method. The total yield clipping method over estimated the yield which could be obtained by grazing lactating cows by several times. There was a considerable difference for the two species.

As indicated by coefficients of variation, digestibility was the most precise measure obtained. The others in order of decreasing sensitivity were milk production, fat percent in milk, and FCM production. TDN by animal requirement method, FCM persistency, TDN by cage clippings, and body weight changes.

GA. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Offutt, M. S., Jacks, J. F., and Taylor, M. LAHONTAN - A NEW VARIETY OF ALFALFA RECOMMENDED FOR EASTERN ARKANSAS. Ark. Farm Res. 7(1): 7. 1958.

Lahontan is a new variety of alfalfa that is adapted to the heavy clay (gumbo) Delta soils of eastern Arkansas. It was developed cooperatively by the U. S. Department of Agriculture and the Nevada Agricultural Experiment Station and officially released for seed increase in 1954. It has been under test in Arkansas since that time to determine its adaptation to Arkansas conditions.

Lahontan is a synthetic variety originating from five plants selected from the Nemastan variety. This new variety is purple-flowered and up-right in growth. It blooms several days sooner after cutting than do Buffalo and Ranger. Lahontan also is more vigorous in the seedling stage than either Buffalo or Ranger, and, due to its rapid recovery after cutting, it usually will produce one more cutting each season than will either of these varieties.

Lahontan is more resistant to bacterial wilt than either Buffalo or Ranger -- an important factor on wilt-infested soils. It also is highly resistant to the spotted alfalfa aphid, a small yellowish-green insect capable of killing alfalfa in the seedling stage and of causing extreme defoliation of the leaves on older plants. This new variety has good resistance to crown rot, and as a result, will tolerate wetter conditions during the winter than will other varieties now recommended for the Delta.

It is susceptible to several of the common foliar diseases, however, and yield reductions may occur in seasons when these diseases are prevalent.

Experimental results indicate that Lahontan is similar to Buffalo and Ranger in protein and fiber content.

Yield trials conducted in north-eastern Arkansas show that Lahontan is superior to Buffalo and Oklahoma Common on very heavy clay soils and that it is equal to Buffalo and Ranger on medium heavy to heavy clay loam soils. On sandy soils, however, Lahontan was less productive than Buffalo and Kansas Common. On the basis of these yield trials, Lahontan has been placed on the 1958 list of recommended alfalfa varieties for eastern Arkansas.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Stoeckeler, J. H. PRELIMINARY OBSERVATIONS OF PERENNIAL LUPINE AS A COVER CROP IN FIELD-PLANTING SITES AND FOREST NURSERIES IN WISCONSIN. Soil Sci. Soc. Amer. Proc. 22: 170-173. 1958.

Plantings of perennial lupine (*Lupinus perennis*) were observed over a 4-year period on 12 field-planting sites in northeastern Wisconsin and in 2 forest nurseries.

On nonirrigated field plantings production varied considerably by sites. On sites of reasonably good nutrient content and moisture relations oven-dry weight of the crop per acre was in the range of 3,136 to 3,762 pounds per acre in the fourth year, with a nitrogen equivalent of 60 to 73 pounds per acre. The author concludes that for nonirrigated field sites it appears that perennial lupine is fairly successful in the general latitude of northern Wisconsin on soils classed as upland loams or in sandy areas with adequate moisture. It has done poorly on very sandy, droughty areas or on sites with considerable sod competition.

In irrigated nurseries it produced an average of 3,203, 4,792, and 12,180 pounds per acre of oven-dry material in the first, second, and third years respectively. Average

nitrogen content on a per-acre basis ranged from 55 pounds the first year to 311 in the third year. Seed production in a second-year nursery planting was 480 pounds per acre and in a third-year stand, 812 pounds per acre.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

Morey, D. D. RADAR OATS: TWO DUAL-PURPOSE VARIETIES FOR SOUTH GEORGIA. Ga. Agr. Expt. Sta. Mimeo. Ser. N. S. 60, 6 pp. 1958.

Radar 1 and Radar 2 are early maturing, disease resistant oats which give good yields of green forage and grain in the Coastal Plain area. Radar oats come into head a week to ten days earlier than Victorgrain 48-93 at Tifton, and a few days earlier than Suregrain and Moregrain oats. These varieties are resistant to most races of crown rust against which they have been tested. They are not resistant to the new and highly-virulent races 264 and 290 reported recently in Florida. Radar oats are resistant to races 6, 7, 7A and 8 of stem rust. They are resistant to the Fulghum and Victoria races of Southern oat smut but are somewhat susceptible to the Fulgrain 3 race. These oats are highly resistant to Victoria blight (*H. victoriae* M. and M.). Radar oats are susceptible to soil-borne mosaic, believed to be a virus condition. For this reason they are not recommended for the Piedmont or Mountain areas. Soil-borne mosaic has not been serious in South Georgia. However, Radar oats are also susceptible to "red lead", a condition which may occur in irregular areas in fields in South Georgia.

These two selections are hardy enough in South Georgia and are not intended for growing in North Georgia. They have a semi-upright habit of growth and are quite well adapted for early and mid-winter grazing. They are not tall, have relatively strong straw, and stand well for combine harvesting under most conditions. The grains thresh clean of awns and hairs and are of moderately good test weight and quality.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr. Athens, Ga.

Caviness, C. E., and Walters, H. J. HILL, A NEW EARLY-MATURING SOYBEAN. Ark. Farm Res. 8(4): 2. 1959.

A new soybean variety that is high yielding, disease resistant, low in lodging, and shatter resistant recently has been released. This new variety, named Hill, is considered an early variety in Arkansas since it matures about three days earlier than Dorman and about eight days earlier than Dortchsoy 67.

Experimental results to date indicate that Hill is superior to the early-maturing varieties being grown at present and it is designed for use on the acreage presently grown to these varieties.

In general appearance Hill closely resembles the Lee variety, but it is about three weeks earlier in maturity. Hill has brown pubescence, light pods, and a plant type similar to Lee's. Hill differs from Lee in that the flowers are white and the seeds, which are yellow and slightly smaller than those of Lee, have light brown hilums.

The Hill variety is adapted to all areas of Arkansas and should be grown along with the later-maturing varieties Hood and Lee. The primary advantage of an early variety, in areas where later varieties can be grown, is to lengthen the harvest period, which permits harvesting a larger acreage per combine. Use of varieties differing in maturity also distributes weather hazards in production and harvesting. Also, by using an early-maturing variety it may be possible to harvest the soybeans early enough to seed a small grain crop at about the recommended date.

Although Hill is earlier than Dorman and Dortchsoy 67, it yields more than Dorman and about the same as Dortchsoy 67. It is more resistant to lodging, diseases, and shattering than Dorman and Dortchsoy 67, but it does not hold its seed as well as Lee. Hill averages about 30 inches in plant height, which is about 2 inches shorter than the other varieties in its maturity group.

Hill is comparable to Lee in resistance to diseases. It is highly resistant to the major foliar diseases bacterial pustule, wildfire, and frogeye. It is as resistant to bacterial blight and to the races of downy mildew present in Arkansas as any other soybean variety grown in the state. Field observations indicate that Hill possesses good resistance



to Phytophthora rot. Also, it appears to be less susceptible to temporary top yellowing (bacterially induced chlorosis) than are Lee and Hood.

Seed quality usually is superior to that of Dorman and Dortchsoy 67 but, as with other early varieties, quality of the seed is relatively poor if the beans mature during hot, dry weather.

The oil and protein content of Hill are satisfactory and very similar to those of Dorman and Dortchsoy 67.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Thurman, R. L. GRAIN SORGHUMS, SILAGE SORGHUMS, AND CORN FOR SILAGE. Ark. Farm Res. 7(1): 8. 1959.

Grain sorghum hybrids have been tested by the Arkansas Agricultural Experiment Station during the three years 1956 to 1958.

RS 610 produced the highest grain yield per acre when planted early and Texas 660 gave the highest yield when planted late. RS 590 (an early hybrid) and Texas 620 produced about the same grain yields per acre as Texas 660 when planted early but somewhat less when planted late.

E56a, which has semi-open heads, produced significantly lower grain yields than the hybrids just named. It gave higher grain yields when planted late than when planted early. D50a hybrid has been somewhat taller than the other hybrids, averaging 53 inches in height, which appears excessive for combine harvesting. Its height is more pronounced when it is planted early. Taller plants contribute to a higher lodging percentage.

The superior grain sorghum hybrids have produced an average of about 20 percent higher grain yields per acre than the open-pollinated varieties, although it should be kept in mind that some hybrids are not superior to the open-pollinated varieties. Careful selection of the superior hybrids is essential to secure the higher yields. It is also essential to use good quality planting seed to insure stands and to guard against off-type plants in the field.

Hybrid silage sorghums have been tested for only two years, and several hybrids have been tested for only one year. The early hybrids have not exceeded the open-pollinated variety Atlas in green-weight tonnage yield per acre, and the late maturing ones have not exceeded Tracy in yield.

U. Ark., Agr. Expt. Sta., Fayetteville Ark.

Waddle, B. A. REX, A NEW ARKANSAS COTTON. Ark. Farm Res. 7(4): 5. 1958.

Rex, a new strain of cotton in process of being released to Arkansas growers, promises to fill a need for an early-maturing variety with large bolls, resistance to storm losses, competitive staple length and gin turn-out, and resistance to certain diseases attacking cotton. Experimental data from three years' testing indicate that this new strain will produce competitive yields which are matured 10 days to two weeks earlier than commercial varieties currently being grown.

Rex was developed by Carl Moosberg, who was attempting to combine resistance to two diseases of cotton into one variety. He recovered resistance to bacterial blight disease and the same level of resistance to Fusarium wilt as carried by the Empire WR parent, and the seedling vigor and large boll characters from the Empire parent. He also uncovered new gene combinations giving the new strain higher gin turn-out and earlier maturity than either parent.

Subsequent testing has indicated that Rex can be used profitably to replace current early-maturing varieties.

Where growers need maximum yields that utilize the full season growth and fruiting of the plant, they should plant currently recommended full season varieties.

Plants of Rex generally will be shorter in height than current varieties and especially so if an early fruit load is set. Staple length runs 1-1/32 to 1-1/16 inches. Gin turnout runs 36 to 38% although 34 to 36% has been recorded in wet seasons for cottons grown under high fertility. The quality of fiber produced is equal or superior to that of competitive early-maturing varieties.

High yielding potential, resistance to storm loss, early maturity, and resistance to certain diseases attacking cotton make Rex a contribution toward a better cotton economy in Arkansas.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Moore, J. N. NEW BLUEBERRY IS INTRODUCED. N. J. Agr. 41(6): 4-5. 1959.

Since 1959 seven new varieties of blueberries, characterized by their uniformly large fruit, have been introduced for New Jersey and the Northeast. Collins, the eighth in the series, fills a gap in the ripening season between Earliblue and Blue-ray.

Collins is very similar to Earliblue except for ripening 5 to 7 days later, Collins bushes are erect, vigorous, and moderately productive. Fruit buds possess about the same cold hardiness as those of Berkeley and Earliblue, but the flower buds are somewhat sensitive to cold, being in a class with Berkeley in this respect.

The fruit is borne in medium-sized rather tight but attractive clusters. Fruit is large, light blue, firm, highly flavored and does not crack or drop upon maturity.

Rutgers Agr. Expt. Sta., New Brunswick, N. J.

Agriculture Research Service SESAME PRODUCTION. U.S.D.A., Farm. B. 2119, 12 pp. 1958.

Sesame is a promising new crop for farmers in the southern half of the United States. It is especially promising for farmers who operate under acreage restrictions on basic crops.

Sesame can be grown, generally, wherever cotton can be grown, and it yields approximately the same amount of seed per acre.

Because of its high oil content--about 50 percent--the seed is worth more to oilseed producers than any other edible oilseed.

Marketable sesame products are the whole seed, the oil, and the meal. The whole seed is used in making a variety of breads, cakes and candies. The oil, pressed from the seeds, is used as salad or cooking oil, and in making shortening, margarine, cosmetics, medicines, and insecticides. The meal, left after the pressing operation, is a good feed for cattle and poultry. The stalks are often plowed under as a source of organic matter.

This Farmers Bulletin describes; varieties recommended; temperature, moisture and soil requirements needed; cultural practices; harvesting; diseases and insect pests; and how to market the crop.

ARS, USDA, Inform. Div., Washington 25, D. C.

## Woodlands

Doolittle, W. T. SITE INDEX COMPARISONS FOR SEVERAL FOREST SPECIES IN THE SOUTHERN APPALACHIANS. Soil Sci. Soc. Amer. Proc. 22: 455-458. 1958.

The paper gives methods and results of a study of relationships of site indices of 10 tree species common in the Southern Appalachians. These species are: scarlet oak, black oak, northern red oak, chestnut oak, white oak, white pine, shortleaf pine, pitch pine, Virginia pine, and yellow-poplar. Site indices of the 10 species were correlated by regression methods so that when the site index of 1 species is known for a given piece of land, it is possible to determine, by use of equations or a chart, the site index for 1 or all of the other 9 species. Results of a special field test showed that the standard error of estimate for predicting site index of scarlet oak from other species was  $\pm 5.36$  feet by using equations and  $\pm 5.28$  feet by using the chart. White pine had the highest site index on all lands or sites except on the best, where yellow-poplar was superior. Of all species, the chart shows the yellow-poplar is the most responsive to site change; it has the highest site index on the best sites and the lowest site index on the poorest sites.

FS, USDA, Washington, 25, D. C.

Copeland, O. L., Jr. SOIL-SITE INDEX STUDIES OF WESTERN WHITE PINE IN THE NORTHERN ROCKY MOUNTAIN REGION. Soil Sci. Soc. Amer. Proc. 22: 268-269. 1958.

This paper reports results of a study on 37 plots that show the relationships of certain physical soil properties to site index (at age 50) of western white pine. Thirty-seven plots of western white pine in the 60 to 180 year class from Idaho, Washington and Montana were studied. White pine site curves developed by Haig were used to determine site index at age 50. Site index is correlated significantly with effective soil depths, depth to the zone of reduced permeability, and the available water-holding capacity of the top 3 feet of soil. Regression equations and confidence limits at the 5% level of significance are included. Applications of these relationships in forest management are discussed.

Intermountain Forest and Range Expt. Sta., FS, USDA, Ogden, Utah.

White, D. P., and Wood, R. S. GROWTH VARIATIONS IN A RED PINE PLANTATION INFLUENCED BY A DEEP-LYING FINE SOIL LAYER. Soil Sci. Soc. Amer. Proc. 22: 174-177. 1958.

Investigation of site factors responsible for a highly significant growth difference between two contiguous parts of a red pine plantation showed that important effects were related to a deep-lying fine soil layer. The growth difference between two adjacent parts of this 25-year-old stand established on an old field (Hinckley coarse sand) has been attributed to differences in land use. Investigation of chemical and physical soil properties in the solum and parent material above 6 feet showed no important differences. Exchangeable soil potassium in both areas was exceptionally low in the solum under both stands. However, the height of the food portion was over 60% greater than the poor part.

Growth differences, chemical and physical soil profile properties, soil moisture depletion, and foliar potassium were measured during the period October 1954 to October 1956. Differences in growth were found to be closely related to a deep-lying silty fine sand layer situated at varying depths under the two stands. This layer provided an ample supply of water and additional available potassium to the good stand but not to the poor.

It was concluded that chronic drought and potassium deficiency are both limiting in this stand. When the fine soil layer was not deeper than 6 feet, the tree roots absorbed adequate amounts of potassium and considerably more soil water than when the fine layer occurred deeper than 6 feet.

Charts and tables.

State U. Col. Forestry, Syracuse, N. Y.

Youngberg, C. T. THE INFLUENCE OF SOIL CONDITIONS, FOLLOWING TRACTOR LOGGING, ON THE GROWTH OF PLANTED DOUGLAS-FIR SEEDLINGS. Soil Sci. Soc. Amer. Proc. 23: 76-79. 1959.

Growth of planted Douglas-fir seedlings was investigated on Reddish Brown Latosol soils on two cutover areas in the Cascade Mountains of western Oregon.

In April 1955, 2-0 seedlings were planted on tractor roads, in loose berm material adjacent to the tractor roads, and on undisturbed cutover condition. First-year survival for all conditions was over 90%, but the 70% survival was slightly smaller on the Cutover area, especially at the end of the second year. Annual height measurements were made at the end of the 1955 and 1956 growing seasons. Differences in height growth between seedlings on the cutover condition and those on the berm and tractor road conditions were highly significant. Seedling growth differences between berm and tractor road conditions were also statistically significant in several instances. Soil analysis data indicated poor growing conditions on the tractor roads, particularly in regard to aeration, moisture, and N relationships, available P and K and pH were highest on the Cutover area and lowest on the roads.

Oreg. Agr. Expt. Sta., Corvallis, Oreg.



Pine must have growing space and sunlight to make satisfactory growth. Under a hardwood over-story, naturally seeded or planted pine trees survive very poorly and make slow growth.

To test methods of removing a competing overstory and to find out how planted pine seedlings grow after such removal, a study was begun at the Southwest Branch Station in March of 1956. The areas treated were hardwood thickets in a pine woodland in which the hardwoods had prevented natural pine seeding from taking place.

All hardwood trees in the 1 inch d.b.h. class and up on two blocks of five plots each were treated as follows: A, the lower 12 inches of the bole was basal sprayed with 2,4,5-T in diesel fuel; B, stems were cut and the cut surface treated with 2,4,5-T in diesel fuel; C, stems were cut or girdled, with no chemical treatment; D, trees were injected with a tree injector using 2,4,5-T in diesel fuel; and E, check plot, received no treatment. Concentrations of 2,4,5-T used were 1 gallon of the chemical (4 pounds acid equivalent) to 24 gallons of diesel fuel for the basal spray and cut surface treatments, and 1 gallon of the chemical to 9 gallons of the diesel fuel for the tree injector.

All plots were underplanted with loblolly pine seedlings at a spacing of approximately 6 feet by 6 feet. Twenty of the competing hardwoods and 10 of the planted pines in each plot were tagged for study.

It is fairly easy to get a top kill simply by cutting or girdling the competing over-story stems. The resulting sprouting from untreated stems, however, will often furnish severe competition. Table 1 shows the results of the various treatments.

The chemical treatments were all satisfactory but the trees died rather slowly in the plots that were basal sprayed and where the tree injector was used. There was very little sprouting after treatment except on the plots that were not chemically treated. Top kill in the check plots was from natural mortality.

Survival and growth of planted pine were directly related to the amount of release provided. Table 2 shows results for the three seasons.

Table 1. Top Kill and Sprouting of Over-story Hardwoods

Plot treatment	Percent top kill	Percent sprouting
A. Basal sprayed	90.0	0.0
B. Stem cut, surface treated	100.0	0.0
C. Cut or girdled only	100.0	72.5
D. Tree injected	92.5	2.5
E. Check, no treatment	7.5	0.0

Table 2. Survival and Growth of Under-planted Pine After Three Growing Seasons

Plot treatment	Percent survival	Av. height in feet
A. Basal sprayed	60	2.6
B. Stem cut, surface treated	80	5.6
C. Cut or girdled only	80	3.8
D. Tree injected	60	2.3
E. Check	20	1.3

U. Ark., Ark. Expt. Sta., Fayetteville, Ark.

Olson, J. S., Stearns, F. W., and Nienstaedt, H. EASTERN HEMLOCK. Conn. Agr. Expt. Sta. C. 205, 24 pp. 1959.

The development of hemlock cones requires a little over one year from the time the flower buds are formed until the seed is shed. Seed is produced in some abundance at intervals of 2 or 3 years.

Seed retains good viability for at least 2 years if stored dry in sealed containers in a refrigerator operating at about 35°.

Stratification, i. e. the chilling of moistened seed, is essential for rapid germination. In nature, or in fall-sown nursery beds, seed is stratified and ready for quick germination the following spring, but losses from rodents and other causes may be very

high. A better practice is to stratify seed artificially during the winter and sow as early as possible in the spring while air temperatures are below 60°.

Germination of spring-sown unstratified seed may be greatly delayed. This exposes seed and seedlings to serious loss from many causes.

Hemlock seeds will germinate, though quite slowly, at temperatures as low as 45° but germination levels are lowered by temperatures constantly in the upper 70's. Best results are obtained when temperatures fluctuate between about 70° during daytime and about 55° at night.

Light seems to have little effect on the germination of stratified seed but at favorable temperatures 8 to 12 hours of light daily improves germination of otherwise sluggish unstratified seed.

In nature seedlings form buds in late summer, are chilled during the winter, and start new growth early the next spring. If seedlings are brought into a greenhouse in the early fall before they have been chilled, they will not break dormancy and start new growth unless they are subjected to daylengths of 16 hours or more.

For maximum growth, seedlings require 16 to 20 hours of light daily. Breaking a 12- to 16-hour night with one or more periods of dim incandescent light of several hours duration will result in about as much growth as 16 to 20 hours of daylight.

Temperatures which vary between 80° to 90° during the day and 50° to 60° at night, or constant temperatures in the range of 55° to 70°, are very favorable for seedling growth. Plants are stunted at constant temperatures above 90°; their growth is slowed down at constant temperatures below 50°.

Seedlings from northern or high altitude sources tend to become dormant early and so produce less growth than seedlings from southern or low altitude sources. The latter may continue to grow too late in the fall and be frost killed. It is best to get seed from sources of approximately the same climatic region as the place where the trees are to be grown.

Seedlings will grow quite satisfactorily at the moderate levels of nutrition typical in nature but not if certain elements are grossly deficient. Over-fertilization may lead to root rot or damping-off, or may unduly prolong the period of active growth, with consequent winter injury.

The light intensity required for photosynthesis to exceed respiration is below 100 foot candles but established seedlings respond vigorously to light of much higher intensity.

Moisture is essential for germination and early seedling growth. Even after the root system is established, moisture is important for optimal growth.

Although the requirements for germination and early growth are quite critical, hemlock is unusually well adapted to natural establishment under forest cover. Seeds fall to the ground about mid-October and many are soon stratified.

Hemlock seedlings are truly shade-tolerant plants. Their ability to survive in deep shade, then to thrive in bright light when the canopy opens, makes hemlock a formidable contender for a prominent place in our mixed forests.

The frequently erratic behavior of hemlock when planted in the open is due, in large measure, to lack of the favorable conditions natural to the forest.

Conn. Agr. Expt. Sta., New Haven, Conn.

Ike, A. F., Jr., and Stone, E. L. SOIL NITROGEN ACCUMULATION UNDER BLACK LOCUST. Soil Sci. Amer. Proc. 22: 346-349. 1958.

Soil nitrogen accumulation beneath stands of black locust, a leguminous tree, was studied at four locations in Tompkins County, N. Y. Adjacent areas identical in prior treatment served as controls. Significant increases were found under three 16- to 20-year-old plantations but not under a 5- to 10-year stand. These changes extended below the 0- to 7-inch depth, with total nitrogen increases of approximately 600 pounds per acre in the 0- to 20- inch layer.

In a greenhouse study of availability, Sudangrass cultures were able to absorb somewhat larger amounts of nitrogen from soils under locust. Measurement of nitrogen in ground vegetation and estimates of return by locust foliage indicate an annual turnover in excess of 50 pounds per acre.

N. Y. State Col. Agr., Cornell U., Ithaca, N. Y.

Leaf, A. L. DETERMINATION OF AVAILABLE POTASSIUM IN SOILS OF FOREST PLANTATIONS. Soil Sci. Soc. Amer. Proc. 22: 458-459. 1958.

Various soil biological and chemical tests were compared in respect to their suitability for predicting deficiency of potassium for red pine grown on soils of Wisconsin and New York. The biological tests were accomplished by the Azotobacter and (*Aspergillus niger*) methods. The chemical tests included extraction of soil by N  $\text{NH}_4\text{OAc}$  of pH 6.9 and 4.6, extraction by  $\text{N}_4\text{NH}_4\text{NO}_3$  of pH 6.9 and 4.0, extraction by 0.4 N HCl, ignition of ammonium-saturated soil followed by extraction with neutral N  $\text{NH}_4\text{OAc}$ , and extraction with boiling N  $\text{HNO}_3$ . The last method provided the sharpest distinction between potassium-deficient and nondeficient forest soils as detected by the rate of growth and response of plantations to application of potash fertilizers.

U. Wis., Madison 6, Wis.

Voigt, G. K., Stoeckeler, J. H., and Wilde, S. A. RESPONSE OF CONIFEROUS SEEDLINGS TO SOIL APPLICATIONS OF CALCIUM AND MAGNESIUM FERTILIZERS. Soil Sci. Amer. Proc. 22: 343-345. 1958.

Coniferous seedlings and transplants growing in two nurseries located on coarse sandy soils in northern Wisconsin showed intense yellowing of the outer portions of needles or, in severe cases, the entire foliage. This condition was accompanied by a greatly reduced rate of growth. Greenhouse and sample plot trials revealed that the yellowing was caused by acute deficiency of both calcium and magnesium in available or exchangeable form. The results of soil and foliar analyses suggested antagonistic interrelationships between calcium and magnesium and potassium. The normal color and rate of growth of seedlings were restored by application of 1 ton per acre of dolomitic limestone. A similar effect was produced by rototilling a 6-inch topdressing of leaf mold from a productive hardwood-coniferous stand.

Lake States Forest Expt. Sta., FS, USDA, and U. Wis., Madison, Wis.

Davidson, H., and McCall, W. FERTILIZER STUDIES ON TAXUS. Quarterly B. Mich. Agr. Expt. Sta. 42: 317-322. 1959.

The most important evergreen in landscape plantings in Michigan and other states of similar climate is the Taxus. This position of eminence is due to its dark evergreen needles, its attractive red fruit (on some clones), its relative freedom from insects and diseases, its adaptability to most soils, its high degree of tolerance to shade and to the fact that it is available in many forms. Nurseymen devote considerable acreage and time to the production of Taxus.

In order to determine the response of Taxus to fertilizer, two experiments were begun in the spring of 1957 on a Miami loam at the Michigan State University nursery in East Lansing.

On the basis of the data from this experiment, the following recommendations may be made:

1. When fertilizing Taxus with a complete fertilizer, such as 12-6-6, not less than 1 pound nor more than 3 pounds per 100 square feet should be used.
2. When using 33-0-0 or 0-0-60 as a top or sidedressing for Taxus plantations, use less than 1 pound per 100 square feet.
3. Taxus plants should be grown in a soil with a soluble salt level less than 90 mhos  $\times 10^{-5}$ . Death results at levels in excess of 155 mhos  $\times 10^{-5}$ .
4. Soil tests should be made periodically and fertilizer applied accordingly. Suggested levels of nutrition:

$\text{NO}_3$	150 pounds per acre
P	50 pounds per acre
K	125 pounds per acre

Mich. Agr. Expt. Sta., East Lansing, Mich.



Vlamis, J., Schultz, A. M., and Biswell, H. H. NUTRIENT RESPONSE OF PONDEROSA PINE AND BRUSH SEEDLINGS ON FOREST AND BRUSH SOILS OF CALIFORNIA. *Hilgardia* 28: 239-254. 1959.

This report describes three upland soils, Holland sl, Salminas l and Maymen stony l, and the nutrient responses of seedlings growing on them. The plants used in this study were ponderosa pine (*Pinus ponderosa*) and three brush species: deerbrush (*Ceanothus integerrimus*, Lake County form and var. *californicus*), chamise (*Adenostoma fasciculatum*), and western mountain mahogany (*Cercocarpus betuloides*). The responses of these plants to various nutrient combinations were compared with those of two standard test plants--Romaine lettuce and barley.

The soils were deficient in nitrogen and phosphorus as determined by the growth response of standard agricultural test plants, lettuce and barley. The pine and brush seedlings responded to the addition of nitrogen, except for a few ceanothus plants which were found to have nodules on the root systems. On two of the soils studied the pine and brush seedlings gave little or no response to phosphorus. Seedlings grown in the third soil gave a substantial response to phosphorus, and it was established by chemical tests that this soil was of the phosphate-fixing type. There was no significant response to potassium on any of the soils.

Calif. Agr. Expt. Sta., U. Calif., Berkeley, Calif.

### Windbreaks

Woodruff, N. P., Read, R. A., and Chepil, W. S. INFLUENCE OF A FIELD WINDBREAK ON SUMMER WIND MOVEMENT AND AIR TEMPERATURE. *Kans. Agr. Sta. Tech. B.* 100, 24 pp. 1959.

Wind velocity and temperature data were obtained in an open field and to the leeward (north) of a 1/4-mile long, 10-row, 16-year-old field windbreak. Wind velocities were measured at 6 heights ranging from 4 to 40 feet. Air temperatures were measured at 7 heights ranging from 1 to 40 feet. Data were obtained at 9 stations extending to 1,080 feet along a center line and at 7 stations extending to 648 feet along two side lines located 400 feet either side of center, at right angles to the windbreak.

Maximum measured wind velocity reductions in the zone immediately to the leeward of the windbreak were 61, 67, and 63 percent for the east, center, and west lines, respectively. A 50 percent reduction extended leeward to 5, 8, and 4 tree heights along the east, center and west sampling lines. A 20 percent reduction extended to 19.5, 21, and 12 tree heights along the east, center and west lines. A 5 to 7 percent reduction was obtained at 43 H along the center line. The largest proportion of vertical area along a given sampling line had a 10 to 20 percent reduction in wind velocity.

Air temperature differences between leeward and open field varied with the degree of natural atmospheric turbulence at different times of the day or night.

SWCRD, ARS, FS, USDA, and Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

George, E. J. SHELTERBELTS FOR THE NORTHERN GREAT PLAINS. U.S.D.A., *Farm. B.* 2109, 15 pp., illus. 1957.

Recommendations on shelterbelts in this Farmers' Bulletin are based on more than 40 years of research at the U. S. Northern Great Plains Field Station, Mandan, N. Dak. ARS, USDA Inform. Div., Washington 25, D. C.

### Management of Coffee Plantings

Abruna, F., Vicente-Chandler, J., and Silva, S. THE EFFECT OF DIFFERENT FERTILITY LEVELS ON YIELDS OF INTENSIVELY MANAGED COFFEE IN PUERTO RICO. *J. Agr. U. Puerto Rico* 18: 141-146. 1959.

The effect of three levels each of nitrogen, phosphoric acid, and potash, on yields of intensively managed coffee grown in Alonso clay at Castaner were determined. Yields

averaging in excess of 15 hundredweights of market coffee per acre were obtained over 3 successive years, compared to an Islandwide average of about 150 pounds.

A marked response to the application of 150 pounds of nitrogen per acre occurred during all 3 years, with a strong indication of a response to an additional 150 pounds of nitrogen during the 2 years of normal rainfall. A strong response to the application of 150 pounds of potash per acre occurred during the first year, a response to the 300-pound application the second year, and to the 150- and 300-pound levels the third year. There was no significant response to phosphorus in any year.

SWCRD, ARS, USDA, and Agr. Expt. Sta., U. Puerto Rico, Rio Piedras, Puerto Rico.

Vicente-Chandler, J., Abruna, F., and Silva, S. A GUIDE TO INTENSIVE COFFEE CULTURE. USDA., ARS. Prod. Res. Rpt. 31, 51 pp. 1959.

Within territorial United States, Puerto Rico is the major domestic area that produces coffee. However, yields there are extremely low. In 1956-57 the average yield on 176,000 acres was only 150 pounds of coffee per acre--about enough to supply the Island's population.

From 1952 to 1959 studies were conducted in Puerto Rico aimed at increasing the coffee-yield potential of the island in order to place it in a position to compete on the world coffee market. Substituting sun-grown or light-shade-grown coffee for conventional shade-grown coffee, close planting in rows, heavy fertilization and systematic pruning, and pest control with high-yielding varieties is the key to increasing this potential.

By the intensive method described herein, growing coffee on suitable lands should result in yields approximately 1,500 pounds of high-quality market coffee per acre. Recommendations are based to a large extent on experiments conducted in Puerto Rico, by the authors and on their repeated observations and practical experience, along with principles and results obtained under similar conditions in other countries.

ARS, USDA, Inform. Div., Washington 25, D. C.

## Tree Crops

Ruehle, G. D. THE FLORIDA AVOCADO INDUSTRY. Fla. Agr. Expt. Sta. B. 602, 100 pp. 1958.

This bulletin on the Florida Avocado Industry is a complete handbook for the culture of avocados from planting to harvesting.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Sharpe, R. H., and Gammon, N., Jr. PECAN GROWING IN FLORIDA. Fla., Agr. Expt. Sta. B. 601, 67 pp. 1958.

In 1950 there were 284,944 pecan trees of all ages in Florida. The average annual production from 1945 to 1954 was 4,199,000 pounds, of which 2,454,000 pounds were from named varieties.

Varieties selected for planting should be precocious, prolific and consistent in bearing, and carry a high resistance to diseases.

Trees are transplanted during the dormant season from December to March; early planting results in the most satisfactory "live." Trees should not be set closer than 50 X 50 feet, a wider distance being better.

The commercial pecan area in Florida is in the northern and western part of the state, extending southward to about the latitude of Gainesville.

The seedling pecan is the stock on which varieties are budded and grafted. Nuts from trees of seedlings and varieties that require 70 or more to the pound will give good results when planted to produce stocks. The nuts are planted in the fall or early winter 4 to 6 inches apart in 3 1/2-to 4-foot rows.

Budding is mostly done during July and August by ring and patch budding methods. Grafts are made in January and February, using the whip or tongue in the nursery.

Nursery stock should be kept in a thrifty growing condition by adequate fertilization and cultivation. Zinc is used to correct rosette in pecans. It is generally applied as zinc sulfate, either to the soil or as a foliage spray.

Spanish moss can be killed in pecan trees by thoroughly wetting it with a low lime bordeaux mixture, applied with a power sprayer.

Undesirable trees can be top-worked to desired varieties by budding and grafting.

Pecans are harvested mostly in October and November. A mechanical pecan tree shaker is best for removing the nuts from the trees, but poles are still used by many.

Pecan nuts can be stored at 32° F. or slightly lower temperatures and kept in good condition for long periods.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Weaver, R. J., and McCune, S. B. RESPONSE OF CERTAIN VARIETIES OF VITIS VINIFERA TO GIBBERELLIN. *Hilgardia* 28: 297-350. 1959.

Two seedless and five seeded grape varieties were treated with the water-soluble potassium salt of gibberellic acid at different stages of the vines' development. Applications were made by dipping clusters or by spraying shoots or entire vines; concentrations ranged from 0.1 to 1,000 ppm. In all varieties shoot growth was stimulated, and internodes were elongated. Treatment of Black Corinth resulted in an excellent set of large berries, and at the higher concentrations berries were elongated. In Thompson Seedless some treatments hastened flowering and produced more elongated clusters and peduncles, others resulted in increased berry size. Flowering was also hastened in Zinfandel and shoots were elongated. Tokay responded with longer leaves and elongated cluster parts. In Ribier and Red Malaga no beneficial results were obtained by dipping clusters, but spraying often hastened coloration slightly and sometimes produced higher Balling readings. Dipping flower clusters of Muscat of Alexandria failed to increase the percentage of set. Considerable numbers of shot berries resulted from some treatments of Thompson Seedless, Zinfandel, Tokay, and Ribier.

Calif. Agr. Expt. Sta., U. Calif., Berkeley, Calif.

Weaver, R. J., and McCune, S. B. GIRDLING: ITS RELATION TO CARBOHYDRATE NUTRITION AND DEVELOPMENT OF THOMPSON SEEDLESS, RED MALAGA, AND RIBIER GRAPES. *Hilgardia* 28: 421-456. 1959.

These studies of changes in carbohydrate levels in the vine resulting from various times of girdling were intended to shed light on why girdling stimulates responses.

Girdling experiments with three varieties of grapes over an eight-year period verified earlier findings or hypotheses that:

1. Carbohydrates are increased above the girdles and decreased in the roots.
2. There is a sensitive time relation between girdling and maximum berry size in Thompson Seedless and between girdling and most rapid increase in maturation in Red Malaga and Ribier grapes.
3. Girdling does not permanently weaken the vines.

Calif. Expt. Sta., U. Calif., Berkeley, Calif.

## ECONOMIC AND SOCIAL

### Costs and Returns

Capstick, D. F., and Meenen, H. J. COST OF HARVESTING COTTON BY MACHINE. *Ark. Farm Res.* 8(4): 3. 1959.

Mechanical cotton harvesters have been accepted rather widely in the major cotton-producing areas of the country since World War II. In the two upper Delta counties of Arkansas -- Mississippi and Crittenden -- the number increased from about 60 in 1950 to 735 in 1956. Since then there has been a slight decline.



The most common mechanical cotton harvester used in the upper Delta in the 1956 to 58 period was the barbed spindle type. Cost data were obtained for one- and two-row machines and for the low-drum and high-drum type of each size. The one-row, low-drum was further sub-divided into two groups because it is rather common to find two different sizes drawn by different sized tractors, one with 20 to 30 drawbar horsepower and the other with 30 to 40 drawbar horsepower.

The average investment used in this study was based on the following new machine costs: one-row low-drum I, \$5,300; one-row, low-drum II, \$5,800; one-row, high-drum, \$7,900; two-row, low-drum, \$14,700; and two-row, high-drum, \$16,400.

Annual fixed cost ranged from \$828 for the one-row, low-drum I machine to \$2,425 for the two-row, high-drum size (Table 1). This includes depreciation, interest, taxes, and insurance. Depreciation was based on an estimated useful life of eight years and a trade-in value of 25 percent. Interest was charged at the rate of 6 percent on the average investment.

Variable cost per acre ranged from a low of \$9.33 per acre to a high of \$15.00 per acre (Table 1). These data represent two pickings per season. Variable cost includes fuel, labor, repairs and maintenance, lubricants, and detergent. In addition, in the case of the one-row machines, the variable cost includes the cost of operating the tractor used to pull the machine. In the study it was found that 44 percent of the annual use of the tractor was devoted to operating the cotton picker, and this proportion of the total cost was included in the variable cost of harvesting cotton mechanically. Two-row machines were self-propelled.

Although many factors influence the range in cost of picking cotton mechanically, the cost per bale is influenced primarily by the number of bales picked and the yield of cotton. Assuming no variation in the efficiency of the mechanical picker, the cost per bale of picking cotton with a one-row, low-drum I machine would be reduced from \$35, if only 100 bales of cotton from land yielding 300 pounds of lint are harvested, to \$14 if 200 bales from land yielding 600 pounds of lint are harvested (Table 2). Similar comparisons can be made for the other machines.

The total cost of harvesting cotton mechanically should include the field and grade loss resulting from this method of harvesting. A comparison of field loss indicated that mechanical harvesting was 91 percent as efficient as hand harvesting. The average reduction in value per bale for machine harvesting compared to hand harvesting was \$37.76.

The annual capacity of mechanical pickers was estimated to be 150 acres for one-row and 270 acres for two-row machines (two pickings per season). If the machine was used for 150 acres or less, the cost per bale was lower with a one-row machine. If the acreage exceeded 150, the cost per bale was less with one two-row machine than with two one-row machines.

Table 1. Cost of Operating Mechanical Cotton Harvesters in Two Upper Mississippi Delta Counties in Arkansas, 1956-58

Cost item	One-row machines			Two-row machines	
	Low-drum I	Low-drum II	High-drum	Low-drum	High-drum
			<u>Dollars</u>		
Annual fixed cost	827.52	897.77	1,198.69	2,164.67	2,425.04
Variable cost per acre <sup>1</sup>	12.13	13.54	15.00	9.33	9.78

<sup>1</sup>For brevity both fixed and variable tractor costs are included in the variable cost of the one-row machines because tractors were used for purposes other than picking.

Table 2. Machine Cost per Bale for Harvesting Cotton Mechanically for Selected Levels of Annual Use and Lint Yields per Acre, Two Pickings per Season<sup>1</sup>

Bales picked	Pounds of lint per acre			
	300	400	500	600
<u>Dollars</u>				
One-row, low-drum I				
100	34	26	20	17
200	27	20	16	14
One-row, low-drum II				
100	38	28	23	19
200	30	23	18	15
One-row, high-drum				
100	45	34	27	22
200	35	26	21	18
Two-row, low-drum				
100	52	39	31	26
200	34	25	20	17
300	28	21	17	14
400	25	18	15	12
Two-row, high-drum				
100	57	43	34	28
200	37	27	22	18
300	30	22	18	15
400	26	20	16	13

<sup>1</sup>The per bale loss in value due to machine harvesting is not included.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Greene, R. E. L., Kushman, L. J., and Spurlock, H. C. AN ANALYSIS OF QUALITY AND COST OF HARVESTING AND HANDLING POTATOES WITH MECHANICAL EQUIPMENT. Fla. Agr. Expt. Sta. B. 612, 72 pp. 1959.

This report presents data on amount of use, performance, harvesting practices, quality and costs of harvesting and handling potatoes with mechanical equipment in Florida and Alabama in 1953 and 1954. Data are also presented on the costs of harvesting and handling potatoes with conventional methods.

In both Florida and Alabama most units of commercially built 2-row harvesters have been used to harvest from 100 to 125 acres per season, with an occasional machine harvesting about 175 acres. One-row harvesters averaged about 50 acres per machine per season. The rate of harvesting for direct 2-row machines has varied from 1/2 to 1 acre per hour and the volume of potatoes harvested from 75 to 225 packed hundredweights equivalent. Rate of harvesting for 1-row harvesters was from 0.25 to 0.43 acres per hour and volume per hour from 50 to 75 100-pound bags.

Some of the more important factors affecting the amount of physical injuries in potatoes harvested and handled with mechanical equipment are variety, condition of the field at time of harvest, type of protection on the equipment, care with which it is operated and adequacy of packinghouse facilities used to receive potatoes hauled in bulk.

Cost of harvesting potatoes with the conventional method was estimated to be 20.59 cents per 50-pound bag in the Fort Myers area, 18.47 cents in Dade County when the potatoes were handled in field boxes and 14.57 cents when they were handled in field bags. Costs by the conventional method were estimated to be 27.15 cents per 100-pound bag in the Hastings area and 38.57 cents in Alabama. Costs in Alabama were higher as most farmers paid a contract rate of 30 cents per packed bag for picking-up, loading and hauling.

Under conditions and rate of harvesting that occurred in the Hastings, Florida, area in 1954, the estimated cost of digging potatoes and placing them on the conveyor to the

washer with a mechanical harvester and bulk equipment was \$47.16 per acre, or 24.3 cents per packed hundredweight. This amount was about 2.8 cents less per bag than the estimated cost of harvesting potatoes with conventional methods. Cost with a 1-row harvester was about 1.6 cents per bag more than that with a complete 2-row direct harvester.

In Alabama in 1954 costs with the various makes of mechanical equipment were about 31.5 cents per hundredweight, about 8 cents less than harvesting in the usual way.

The main factors affecting costs per unit of harvesting and handling potatoes with mechanical equipment were variations in the volume of potatoes harvested per hour and the number of hours the equipment was used per season. In the Hastings area for Make B equipment, assuming a yield of 154 bags per acre, cost was estimated at 45.5 cents per bag for an annual use of only 100 hours and a rate of harvesting of only 90 bags per hour. This compared to 18.2 cents for the same yield with an annual use of 300 hours and a rate of 190 bags per hour.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Reuss, L. A. COSTS OF CLEARING LAND AND ESTABLISHING IMPROVED PASTURES IN CENTRAL FLORIDA. Fla. Agr. Expt. Sta. B. 600, 40 pp. 1958.

Development of improved pastures in Florida was stimulated especially during the period 1942 to 1952 by factors such as high prices for beef cattle, new findings in agricultural research, better equipment, improved grasses and government incentive payments. After cattle prices declined, emphasis shifted (1952 to 1957) to clearing land for citrus groves and vegetable production.

The future rate of expansion of improved pastures depends greatly upon the expected levels of beef prices and ranch operation costs. The cost of developing improved pastures is an important factor in total costs and in the outlook for the beef industry. Factors that make for efficient production response make for profitable use of improved pastures. Low land-development costs, favorable operating conditions and satisfactory beef prices are conditions which will substantially enhance the chances of increasing net returns to ranchers from clearing land and installing improved pastures.

Total costs per acre for clearing land, preparing the seedbed, adding soil amendments and seeding forage plants depend largely upon the density of cover of trees and plants that must be eradicated and also upon the amount of drainage work required. Per-acre costs calculated from records for 1951-53, a period of rapid pasture development, are as follows: \$33 to \$89 in the Pasco County area; \$25 to \$55 in the Indian River-St. Lucie area; and \$31 to \$63 in the DeSoto County area.

Per-acre costs of clearing comparable land for pastures increased approximately 15 percent from 1952-53 to 1956-57.

In general, the clearing of sites for groves, vegetables and subdivisions that is now going on is more difficult than earlier clearing for pastures, because the sites now being cleared are generally more rolling in topography, more densely covered with trees or more in need of drainage.

Available ranch records indicate that increases in per-acre inventory value of \$40 to \$150 may be expected currently when native rangeland is converted to improved pastures under conditions found in many parts of central Florida. The investments in land and livestock increase, as also do annual operating charges for items such as fertilizer and labor. Per-acre annual operating charges may increase as much as \$18 to \$38 per acre. Production increase in terms of pounds of beef per acre required to break even vary directly with annual costs and inversely with the per pound price of beef animals. Unfavorable production conditions, high development costs or low beef prices will substantially reduce the chance of increased net returns from improved pasture. The continued expansion of vegetable production onto new lands, suitable thereafter for conversion to improved pastures at nominal added cost, is a highly favorable factor in the outlook for pastures in Florida.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.



Cotner, M. L., and Jameson, D. A. COSTS OF JUNIPER CONTROL: BULLDOZING VS. BURNING INDIVIDUAL TREES. Rocky Mountain Forest and Range Expt. Sta., Paper 43, 14 pp., illus. 1959.

Two methods of studying costs of juniper control based on records of control operations in Arizona are reported: (1) Burning individual trees with either 1- or 2-man crews; and (2) bulldozing. Size of trees, number per acre, and hourly charges of labor and equipment, are the chief variables that determine costs. A technique for predicting costs of juniper control by these methods is presented. Costs of 15 separate bulldozer operations and 1 burning operation were found to be within 10 percent of the costs computed by the technique presented. This suggests that the technique can be used to determine the least cost method if differences between them are not more than 10 percent.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

Butler, C. P., and Lanham, W. J. AN ECONOMIC APPRAISAL OF THE CONSERVATION RESERVE PROGRAM IN AREA III B, UPPER COASTAL PLAIN OF SOUTH CAROLINA. S. C. Agr. Expt. Sta. AE 135, 59 pp. 1958.

This report presents the findings of a study of some of the effects of the Conservation Reserve in one of the major type of farming areas in South Carolina. The information not only contributes to a better understanding of the effects of the program by the program administrators, but it also provides information that should be of interest to all agricultural leaders in South Carolina.

Preliminary reports from the 1958 participation show an increase of 54 percent in the acreage put in the Conservation Reserve in this area.

FERD, ARS, USDA and S. C. Agr. Expt. Sta., Clemson Agr. Sta., Clemson, S. C.

McArthur, W. C., and Carreker, J. R. ECONOMIC ANALYSIS OF CONSERVATION FARMING ON A COTTON-DAIRY FARM IN THE PIEDMONT AREA OF GEORGIA. Ga. Agr. Expt. Sta., B.N.S 51, 45 pp. 1958.

In 1941, a farm management unit was established on the Southern Piedmont Conservation Experiment Station at Watkinsville, Oconee County, Georgia. This farm unit was used to test the technical and economic feasibility of different soil-conserving methods and practices in the setting of the farm as a whole. The purpose of this study was to evaluate the use of resources in and income from selected soil-conserving systems of farming as followed on this unit during the period 1944-55.

FERD and SWCRD, ARS, USDA, and Ga. Agr. Expt. Sta. U. Ga. Col. Agr., Athens, Ga.

Kline, R. G., and others. FARM SIZE AND OUTPUT RESEARCH. -A STUDY OF RESEARCH METHODS. South. Coop. Ser. B. 56, 121 pp. 1958.

This bulletin is the fifty-sixth in the series of Southern Cooperative Bulletins. It comprises a collection of research papers assembled under the sponsorship of the Southern Farm Management Research Committee, and originally presented at a meeting of this Committee at Memphis, Tennessee, October 2-4, 1957.

Okla. Agr. Expt. Sta., Stillwater, Okla.

Farm Economics Research Division FARM COSTS AND RETURNS, COMMERCIAL FAMILY-OPERATED FARMS BY TYPE AND LOCATION. U.S.D.A., A.R.S. Agr. Inform. B. 176, 71 pp. Rev. 1959.

This annual publication contains information on costs, returns, and related data for 1958 and earlier years for 32 important types of commercial farms in 18 major farming areas in the United States.

Tables, graphs, and data are presented on basic organization of the farm, capital requirements, labor used, sources of income, major expenses, net returns, and index numbers for important factors.

The year 1958 was a relatively favorable one for operators of most types of commercial farms. On 29 of the 32 types of commercial farms for which data are available, net farm incomes in 1958 were higher than in 1957. Compared with a recent 10-year period (1948-57), incomes in 1958 were higher on 25 of the farm types.

ARS, USDA, Inform. Div., Washington 25, D. C.

Hunter, E. C. ECONOMICS OF FORAGE PRODUCTION IN THE MOUNTAIN MEADOW AREAS OF COLORADO. U.S.D.A., A.R.S. 43-99, 54 pp. 1959.

Production of hay is a major cost of ranching in the mountain meadow areas of Colorado. Declining yields per acre, and the relatively high feed requirements per animal unit in these areas that result from the rather long winter feeding period, justify special scrutiny of the management practices and the economics of producing hay on these ranches.

Recent research work in the Colorado mountain meadow areas has shown that certain management practices can be used to increase the quantity and change the quality of hay produced on the average meadow.

The results of feeding trials carried on in conjunction with this research and economic data gathered from ranch operators reveal that certain of the management practices have relatively favorable input-output ratios.

Ranch operators should consider three types of hay for their winter feeding programs: (1) The base feed for the main herd; (2) the base feed for the weaner calves; and (3) if the base feed is of too low quality, supplemental feed, mainly for weaners. In addition, some operators may have potential increases in forage production, which would increase the size of operation.

Generally, the quality of the hay produced is satisfactory for the main herd. Thus, the problem here is one of producing additional quantities of hay at less than the average market price. Applying 40 pounds of available nitrogen annually will produce 0.50 ton per acre of additional hay at a cost of less than \$20.00 per ton. Two other practices, the seeding of legumes into the existing sod, and applying phosphate fertilizer to seeded sod, are economical also.

The operator may want to raise better than average quality hay on specific fields as feed for weaners. The best way to be sure that the desired quality is obtained is to use the two-cut harvest system. Here again, the application of phosphate fertilizer in conjunction with seeding legumes into the sod or the application of 40 pounds of nitrogen fertilizer are the least costly methods of obtaining this type of hay.

If hay containing a high percentage of protein - superhay - is desired as a supplement to lower quality hay, the most profitable practices will involve a two-cut harvest system alone or in conjunction with high rates of nitrogen application - more than 320 pounds.

The practices cited as economically feasible are based on the premise that the practices either reduce the average cost or that the increased value of the hay exceeds the increase in the costs. The analysis does not take into account other benefits that might accrue to an increase in the quantity or quality of mountain meadow hay. Associated economies that might be involved would be the ability of the operator to increase the size of his herd and thereby reduce his average cost of operation per cow-unit, the possible increase in weight of animals caused by feeding the animals a better ration, or reduction in use of summer range that might accompany increased production from meadows.

ARS, USDA, Inform. Div., Washington 25, D. C.

Operations on more than 100 farms were studied in 1957 to learn how farmers have combined livestock with cash crops to increase returns, to utilize available labor fully and to sell homegrown feeds and forage through meat animals and poultry.

The farms studied averaged 340 acres, with 235 acres in cultivation and about 100 acres in permanent grass. Cotton, the major source of income, was produced on about a third of the cropland, corn or grain sorghum on two-fifths and small grain, chiefly oats, on about a fourth of the cultivated land.

Labor and feed requirements and other production costs provide a guide in considering the following enterprises: cow-calf, stocker steer, feedlot steer, sheep, hogs, and laying hens. The added investment for buildings and facilities varied between \$760 and \$2,750, depending on the enterprise.

Average prices received and paid in 1957 were used to develop enterprise budgets for typical farm situations. These budgets can be used to guide farmers in considering one or more of the livestock systems to be added to cash crop production.

The relatively low feed prices, compared with livestock prices, yielded favorable returns from the added enterprises in 1957. This was not true of laying hen flocks and market egg production. Average returns per hour of labor were beef cows, \$3.04; stocker steers, \$13.08; feedlot steers, \$6.68; ewes, \$2.22; brood sows, \$3.25; and laying hens, 68 cents.

On farms with a cow-calf operation, herds numbered 10 to 30 cows. Three to 4 acres of native grass per cow are desirable, which often influenced the size of the enterprise. In general, creep feeding of calves was profitable.

Less time is required with stocker cattle than with other livestock. This enterprise can be profitable when grazing is available. For drylot feeding, animals usually were bought in the fall, grazed about 60 days and then fed for 150 days.

Sheep alone, or with other grazing livestock, were maintained on some farms in flocks of 25 to 150 head. Forage that will support one cow will support five ewes. Lambs marketed near Easter were more profitable than those marketed later.

Confined sow-pig production was the common hog enterprise. Only a few pastures in the area were developed primarily for hogs. Ten to 15 sows were handled economically. In starting a hog enterprise, equipment costs are high; they averaged \$275 per sow for a 10-sow herd.

Ordinarily, family labor was used to tend 500-hen flocks that required about 3 hours of labor per day. A poultry enterprise may be added on farms with little pastureland to keep grazing livestock. Floor feeding, housing and equipment cost about \$4 per layer. Costs ran higher for cage layers.

USDA and Tex. Agr. Expt. Sta., College Station, Tex.

Klosterman, E. W. BEEF CATTLE PRODUCE QUALITY MEAT FROM ROUGHAGE. Ohio Farm and Home Res. 44: 90-91. 1959.

The Experiment Station has maintained a herd of beef cattle at the Southeastern Substation for several years. This herd has been of mixed breeding, including Hereford, Shorthorn and native cows.

In the fall of 1956 ten pairs of calves and in 1957, sixteen pairs of calves of the same breeding and sex and of similar weight were selected. One calf for each pair was sold at weaning to determine the value of the calves at that time. The other calf from each pair was fattened in dry lot. Those fattened were fed to an average weight of 950 to 1000 pounds.

In 1956 and 1957, it was more profitable to feed steer and heifer calves than to sell them at weaning time. These cattle produced a hundred pounds of beef with relatively small amounts of grain. When the over-all weight of beef marketed is considered, with a good portion of it coming from roughage which cannot be used for human food, cattle are relatively efficient in converting grain to meat. This is especially true of fat, slaughter calves sold at weaning.

Southeastern Substation of Ohio Expt. Sta., Carpenter, Ohio.



Van Arsdall, R. N. SELF-FEEDING SILAGE TO BEEF CATTLE FROM HORIZONTAL SILOS. A STUDY OF 49 FARMS. Ill. Agr. Expt. Sta. B. 642, 44 pp., illus. 1959.

Many Illinois farmers self-feed silage successfully from horizontal silos, but others are running into difficulties. They find that they must cope with problems of freezing of silage in winter and loss of palatability in summer, caused by excessive width of the silo in relation to size of the drove; losses from spoilage; reduction in consumption of silage because of overcrowding of the cattle; and inadequate drainage caused by the inadequate slope of the silo.

On the 49 farms with self-feeding systems studied in 1957 and 1958, silage was fed to an average of nearly 100 cattle per farm. Self-feeding began in December and lasted for 4 to 6 months. Daily rates of gain averaged 1.7 pounds for the feeding period. Horizontal rather than upright silos were used because of the lower initial cost, and the reduction in labor expected through self-feeding silo capacities averaged 181 tons of silage, with the initial costs of 200-ton silos ranging from \$5 to \$9 per ton of capacity. Farmers expected their horizontal silos, most of which were constructed by farm labor, to have a useful life of 15 to 30 years.

Making and keeping good silage was a problem on some farms. Inadequate packing along side walls caused spoilage, and surface spoilage was high also. Labor for harvesting and storing silages averaged 4.1 hours per acre for grass silage and 6.9 hours per acre for corn silage. Three types of feeding gates were in use: electric wires, suspended gates, and self-supported gates. The gates performed satisfactorily on two-thirds of the farms, with the suspended gates the most effective in nearly all respects.

Ill. Agr. Expt. Sta., Urbana, Ill.

Morris, H. D., Fleming, A. A., and Kozelinicky G. M. THE INFLUENCE OF FERTILIZATION AND VARIETY ON CORN YIELDS IN THE GEORGIA PIEDMONT. Ga. Agr. Expt. Sta., B. N. S. 55, 22 pp. 1958.

A field experiment was conducted on representative upland Piedmont soil over a three-year period, 1954-55, to determine the effect of varying levels of fertilization on the yield of five corn varieties (Dixie 22, NC-27, Dixie 18, Minhybrid 408, and Hastings Prolific.) Rates of fertilizer applied were equivalent to: (a) none, (b) 250, (c) 500, and (d) 1,000 pounds of 10-10-10 per acre. Results of the investigation may be summarized as follows:

1. Dixie 22 outyielded all other varieties at all fertility levels during the three year period while Hastings Prolific was consistently the lowest yielding variety.

2. The superiority of the adapted hybrids over the open-pollinated variety was more marked during a dry season than during a favorable season and greater at high fertilization rates than at lower fertilization levels.

3. Adapted hybrids responded to each additional increment of fertilizer all three years. The open-pollinated variety did not respond to fertilization during an extremely dry year (1953) and no additional response in yield was obtained from the highest fertilizer rate in a moderately dry year (1954).

4. An average yield of approximately 60 bushels per acre was obtained with Dixie 22 at the highest rate of fertilization over the three-year period. This comparatively high yield, despite unfavorable rainfall, indicates the potential capacity of typical upland Piedmont soils for corn production when adapted hybrids and adequate fertilization are utilized.

5. Increases in corn yields obtained from fertilization were due primarily to two factors: (1) An increase in ear size and (2) an increase in numbers of ears per stalk. Only a slight increase in shelling percentage was obtained above the 250 pound rate of fertilization.

6. The protein content of the corn grain was increased significantly by fertilization. Adapted hybrids, Dixie 22 and N. C. 27, were lower in protein content than the unadapted or open-pollinated varieties; however, the adapted hybrids produced more protein per acre than the low yielding varieties.

7. Cost of production per bushel of corn for Dixie 22 was 60 percent of that for Hastings Prolific at each level of fertilization. Cost varied from \$1.59 for Hastings

Prolific receiving no fertilizer to \$0.67 for Dixie 22 at the highest fertility level. Each increment of fertilizer reduced the cost of producing a bushel of corn for all varieties.

8. Net income per acre from Hastings Prolific was--3.54, 0.68, 2.02, and 4.89 dollars with increasing rates of fertilizer as compared to 6.59, 18.81, 26.89, and 35.40 dollars for Dixie 22 at corresponding levels of fertilization. Greatest profit per acre was obtained when an adapted hybrid was grown with adequate fertilization. The low income realized from fertilization when an open-pollinated variety is grown is probably one factor responsible for the low rate of fertilization of corn in Georgia.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Saunders, F. B., Free, W. J., and Mackie, A. B. PROFITABLE COMBINATIONS OF ENTERPRISES AND LEVELS OF FERTILIZATION FOR SPECIFIED RESOURCE SITUATIONS ON SMALL COMMERCIAL FARMS PIEDMONT AREA, GEORGIA. Ga. Agr. Expt. Sta., B. N. S. 53, 57 pp. 1958.

This study was directed to the problem of determining profitable combinations of farm enterprises and levels of fertilization for families with specified resources on small owner-operated commercial farms of the Piedmont Area of Georgia. The major purpose was to determine optimum farm income plans; that is, those combinations of enterprises and levels of fertilization that maximize net farm income for particular resource situations. The results can be used as general guides for evaluating adjustment opportunities within agriculture for families with similar resource situations.

The specific objectives were: (1) To analyze the importance of fertilizer in determining the most profitable use of all other resources on small commercial farms; and (2) to determine the effects on farm size, degree of mechanization, different levels of additional investment capital, and different levels of operating capital on farm organization, income, and patterns of fertilizer and other resource use.

TVA and Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Martin, L. R., and others. GRAIN MARKETING PROBLEMS IN THE SOUTH. - CHANGING ROLE OF GRAIN PRODUCTION IN THE SOUTH. South. Coop. Ser. B. 60, 103 pp. 1959.

This study is not designed to develop new research results. The objectives are to pull together from whatever sources the information necessary for a better understanding of grain marketing problems in the South, to summarize briefly research results in the South and elsewhere that contribute to more efficient grain marketing, and to indicate the areas where additional research in grain marketing is needed for further increases in efficiency. In a sense, this bulletin is a progress report for five years of SM-11 research operations and a blueprint for the new five years of grain marketing research in the South. The present undertaking attempts to draw upon the accumulated research findings of the states and the U. S. Department of Agriculture in order to evaluate the results for the South as a whole and to outline better the problem areas where future research should be directed.

This study includes information on the following grains: corn, oats, wheat, grain sorghum, and soybeans.

Ark. Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

Magee, A. C., Martin, J. R., and Hughes, W. F. PRODUCTION AND PRODUCTION REQUIREMENTS OF CROPS - ROLLING PLAINS AND NORTH CENTRAL PRAIRIES. Tex. Agr. Expt. Sta. Misc. 328, 14 pp. 1959.

In both the Rolling Plains and North Central Prairies of Texas, dryland crop production predominates. Cotton gets first priority on irrigation water. When water is available, grain sorghum may be irrigated also; irrigation of other crops is relatively small. Production of wheat, oats, and grain sorghum is completely mechanized. Cotton is hoed by hand and much of the crop is hand snapped, but the trend is toward mechanical harvesting. Family labor is used in growing all crops, but extra labor is usually hired

for cotton hoeing and hand harvesting of cotton. Most field crops are grown without commercial fertilizer, although its use is growing.

The report contains a set of tables listing production and production requirements for crops. So far as possible, data are given in physical quantities and represent the usual practices and rates of performance.

The information in the report was obtained largely through a survey of farms in the Rolling Plains. Because of similarity in crop practices, the data are generally applicable to the North Central Prairies, which join the Rolling Plains to the east.

Tex. Agr. Expt. Sta., College Station, Tex.

Magee, A. C., and Hughes, W. F. PRODUCTION AND PRODUCTION REQUIREMENTS OF CROPS - WEST CROSS TIMBERS. Tex. Agr. Expt. Sta. Misc. P. 329, 13 pp. 1959.

Dryland crop production predominates on the generally sandy soils of the West Cross Timbers area of Texas. Cotton and corn once occupied most of the cropland, but corn has largely been replaced by grain sorghum, and peanuts have replaced cotton as the major cash crop. Watermelons are of major importance throughout the area. Irrigation, when practiced, is usually limited to peanuts. On deep sands, wind erosion is commonly controlled by strip cropping, with four rows of grain sorghum between eight rows of peanuts.

This is an area of many small farms. Family labor is used mainly in growing all crops.

The report contains a set of tables listing production and production practices for crops. So far as possible, the data are given in physical quantities that represent the usual practices and rates of performance. The data are based on farmer experience, supplemented in a few instances by the experience of crop specialists working in the area.

Tex. Agr. Expt. Sta., College Station, Tex.

Woodworth, R. C., and O'Neal, W. G. RESOURCE USE FOR CORN PRODUCTION IN THE LIMESTONE VALLEY AREA OF GEORGIA. Ga. Agr. Expt. Sta., B. N. S. 61, 34 pp. 1959.

Many different combinations of resources are used in corn production. Some farmers use high amounts of labor and keep cash operating expense as low as possible. Others use capital to save labor. Some farmers apply superior management and obtain greater yields than are obtained from the same resources on other farms.

The objectives of this study are (1) to show the extent to which different farmers have different cost structures and resource requirements for corn production, and (2) to indicate the nature of adjustment opportunities to produce corn at lower cost.

A survey of 99 farms was complete in the Limestone Valley area in the spring of 1956. Seventy-seven of these farms produced three or more acres of corn in 1955. Distributions showing variations and the degree of similarity in per acre yields, fertilizer rates, fertilizer cost, cash expense, and labor use are presented in graph or table form. Similarly, distributions are presented showing land, labor, and cash expense per bushel of corn produced.

Average resource use per acre was estimated to be \$14.24 in cash expense and 19.4 hours of labor. This amounts to .03 acres of land, .63 hours of labor, and 40.7 cents cash expense per bushel of corn produced. The amount of fertilizer used per acre was significantly related to corn yield for the farms in the survey and accounted for 9 percent of the differences in yields. The results support the contention that fertilizer rates should be adjusted to fit each individual farm situation and that profitable use of additional fertilizer per acre depends to a great extent on whether or not other practices are also changed.

There was considerable variation in returns for the different resources. Distributions of returns (gross receipts minus cash expense) are shown for corn prices of \$1.00 and \$1.30 per bushel. Less than one-half of the farms obtaining high returns to one resource had high returns to all three resources (land, labor, and capital). Slightly



more than one-half of the farms with low returns to one resource had low returns to all three resources. Some farms obtained a high return to one resource at the expense of returns per unit of another resource. Farms with a high return per dollar spent tended to have low cash requirements and a high labor requirement.

When all returns above cash expenses were allocated to labor, 19 percent of the farmers obtained a return of less than \$1.00 per hour of labor when corn was valued at \$1.30, and 40 percent obtained less than \$1.00 per hour when corn was valued at \$1.00 per bushel. The farms with a high labor return tended to have a higher yield and/or a lower labor requirement per acre than other farms.

When all returns above cash expenses were allocated to land, and corn was valued at \$1.30 per bushel, 23 percent of the farms had returns of less than \$25.00 per acre, and 11 percent had returns of \$55.00 or more.

Farmers can sometimes increase returns from corn production by adopting management practices which result in higher yields without increasing labor or cash cost requirements per bushel. Examples of such practices are: changes in land use, improvements in timeliness of operations, use of the best varieties of seed corn, and increased use of fertilizer if fertilization rates are low. Returns also can be increased by substituting another resource for scarce or expensive resources. Examples include: using fertilizer to save land, and using capital in the form of mechanical picking to save hand picking labor.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Puterbaugh, H. L., and Kottke, M. W. TECHNICAL AND ECONOMIC CHARACTERISTICS OF IRRIGATION ON CONNECTICUT FARMS. Conn. (Storrs) Agr. Expt. Sta. B. 340, 42 pp. 1959.

In the summer and fall of 1957, a survey on irrigation practices and problems was made of 167 irrigating farmers in Connecticut. The average number of irrigated acres was 39.1 for vegetable farms, 48.8 for potato-tobacco farms, and 59.2 for dairy farms. Water sources for irrigation were streams, ponds, wells, and city water -- 52.1 percent of the farmers used streams, 68.9 percent used ponds, 3.6 percent used wells, and 4.2 percent used city water. Many farmers used more than one source of irrigation water.

The growing season of 1957 was extremely dry, and many farmers indicated that they considered their water sources inadequate.

A considerable number of steel pipes were in use, although most of the pipe currently being purchased was aluminum. Labor required to move pipe was one of the greatest problems associated with sprinkler irrigation. Total investment in water source and equipment ranged from \$1,000 to \$59,000 and averaged \$6,010.

The greatest interest in additional irrigation appeared to be among dairy farmers. The first consideration of any farmer thinking of irrigating is an adequate water supply. Dairy farmers can often combine stock watering facilities with irrigation water sources. Technical help in designing irrigation water supply facilities is important since farmers tend to under-estimate the quantity of water needed.

Supplemental irrigation may benefit a farmer in two different ways -- it may increase his average income and decrease the variability of his income over a period of years.

A study of rainfall probabilities as they relate to irrigation indicated that adequate rainfall is seldom ideally distributed throughout the growing season.

A budgetary analysis of costs and returns from irrigation of hay and pasture on a typical dairy farm indicated that supplemental irrigation from a stream in combination with other good farming practices was profitable over a period of years. From the calculations, which include no costs for development of a source of water, certain conclusions were drawn.

1. The variable costs of operating the irrigation system in a given year make up a relatively small part of the total costs of irrigating, especially when the hiring of additional labor is not required.
2. Yield response to irrigation in a given year need not be substantial to permit greater additional returns than the variable costs.
3. Over the long run yield response to irrigation will probably have to be greater than 0.5 ton hay equivalent per acre in order for the additional returns to cover the fixed costs of the equipment as well as the variable costs.

4. Since variations in rainfall may reduce the need for irrigation in some years and require intensive applications of water in others, the yield response of forage crops may have to be as much as 1.5 tons per acre in years when irrigation is used intensively to offset the years when it is used less intensively.

Conn. Agr. Expt. Sta., U. Conn., Storrs, Conn.

Kimball, N. D. IRRIGATION DEVELOPMENT IN IDAHO UNDER THE DESERT LAND ACT. Idaho Agr. Expt. Sta. B. 292, 39 pp., illus. 1958.

Public land is still being settled and developed under the Desert Land Act of 1877. From 1950 through 1956, 278 entrymen patented more than 45,000 acres in Idaho. In 1956, three areas of the State were surveyed to learn what was happening to entrymen under the act: (1) Hazelton, a good agricultural area with most land completely developed; (2) Howe, a livestock area with a limited water supply; and (3) Raft River, with land ranging from good to poor and with an indefinite supply of ground water.

At Hazelton, cost of complete development of the average 263-acre unit, including new buildings, averaged \$150 per acre. Such land would sell for about \$400 an acre. Estimated annual net income was \$17,321 for 270 crop acres, and \$8,547 for 150 crop acres. At Howe, most of the successful entrymen had already been farming in the area. They developed an average of 132 acres of new land to add to owned units averaging 223 acres. Using their own equipment for land preparation, and erecting only a few new buildings, these farmers developed land at an average cost of \$56.26 per acre. Developed land was worth about \$150 an acre. Net farm income at Howe was estimated at \$8,127 for a 355-acre unit, and \$6,632 for a 300-acre unit operated independently from an old farm. At Raft River, development of a farm unit cost about \$75 an acre. Entrymen's experiences were too varied to generalize about crop-production possibilities. Developed land was priced at \$200 an acre.

More than half the entrymen were farmers; a fourth were businessmen. Major problems encountered by prospective entrymen were lack of information and the difficulty of obtaining funds to finance land and water development.

Idaho Agr. Expt. Sta., Moscow, Idaho.

Foreman, W. J. SUPPLEMENTAL IRRIGATION IN GEORGIA. Ga. Agr. Expt. Sta., B. N. S. 54, 45 pp. 1958.

The present study was designed to investigate the costs of applying irrigation water to crops under various conditions and the effect of irrigation on the net returns from several Georgia crops. Survey records were obtained from a sample of 87 farmers throughout the State using irrigation in 1954.

Most of the systems studied were installed from 1950 through 1954. More than half of the systems obtained all of their water from ponds, nearly one-fourth from streams, less than one-tenth from wells, and the rest from various combinations of these three sources. More than one-third of the systems watered less than 20 acres of crops in 1954, and about two-thirds watered less than 50 acres. All except two of the systems used rotary sprinklers for distributing water; most of these maintained nozzle pressures between 25 and 70 pounds per square inch. The other two systems distributed water by flooding. Stationary gasoline engines were the most common source of power used.

Several differences in the use of irrigation in the Northern Half and Southern Half of the State were noted, most of them being due to differences in water supply conditions. In the north half of the state, streams constituted the principal source of water supply as there are few ponds and wells capable of delivering enough water for irrigation. In south Georgia, on the other hand, ponds were the primary source of water; and wells were used as a source of some water on about 12 percent of the farms using irrigation.

The majority of the systems were used to water pastures, tobacco, vegetables, or a combination of these crops.

The average investment in water facilities and irrigation equipment was \$6,714 or \$112 per acre of crop watered. The investment per acre declined from nearly \$400 per acre for systems watering less than 20 acres to \$70 per acre for systems watering 100

or more acres. Development of water supplies accounted for almost one-fourth of all investment costs, the pump and power unit for another one-fourth, and distribution equipment for about one-half of all investment costs for the 87 systems.

The average system had annual fixed costs of \$941, annual variable costs of \$617, and annual total costs of \$1,558. Total costs amounted to \$26 per acre of crop watered or \$5.56 per acre inch of water applied when the systems were weighted by size. The average cost of applying an acre inch of water, without regard to size of system, was \$12.29. Total costs per acre inch of water applied declined from \$30.66 for systems applying less than 50 acre inches of water in 1954 to \$4.68 for systems applying 1,000 or more inches.

Returns from using irrigation varied widely by crop but were generally good in 1954, the driest year on record in Georgia. A spot check in 1955 indicated that the 1954 returns were not badly out of line with those for 1955. Tobacco was the crop most commonly irrigated and the one which seems most likely to show a consistent profit from irrigation. Both yield and quality were improved, and gross sales were increased by \$501 per acre on the average. After deducting \$4 per acre for additional fertilizer costs and \$59 per acre for additional harvesting, curing, and marketing costs, there remained a gross return to irrigation of \$438 per acre of tobacco. The five inches of water typically applied cost the operator \$62 per acre, and the net return to irrigation was \$376 per acre of tobacco.

In contrast, other field crops--peanuts, cotton, and corn--showed only modest returns. The net return averaged \$39 per acre. Forage crops showed a net return of \$114 per acre; truck crops \$163 per acre; and tree fruits \$533 per acre. The high return to apples and peaches was largely due to the abnormally high prices of these fruits in 1954. Although irrigation of pastures did not always prove profitable, 12 pastures for dairy cattle showed a net return to irrigation of \$93 per acre; and eight pastures for beef cattle showed a net return to irrigation of \$52 per acre.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Lanham, W. J. ECONOMIC ASPECTS OF SUPPLEMENTAL IRRIGATION THREE YEARS, 1956-1958. S. C. Agr. Expt. Sta., AE 185, 11 pp. 1959.

Irrigation appears to have potential for increasing farm income on many farms in South Carolina. Data in this report relate to 142 farms selected initially in 1956. Irrigation practice records were obtained from each of these farms for three years. These farms were located in two general areas designated, for this report as Upper State and Lower State. The areas are characterized by differences in climate, soils, and types of farming.

The crops selected for study were peaches, tobacco, cotton, corn, alfalfa, and pasture.

At the end of the 1958 crop-year the average investment in irrigation facilities per farm totaled \$5,584 in the Upper State and \$4,697 in the Lower State area. Total annual fixed costs per farm averaged \$876 and \$661 in the Upper and Lower State areas, respectively.

These fixed costs were of considerable significance when calculating the net returns from irrigation per year. The average net returns associated with irrigation per acre irrigated were lower for each succeeding year from 1956 to 1958. In 1958, these average net returns were a loss of \$7.17 per acre of tobacco irrigated, and a gain of \$14.13 for pasture, \$19.40 for alfalfa for hay, \$21.58 for cotton, \$31.14 for corn, and \$97.98 for peaches.

Irrigation does not guarantee high yields. It may result in higher yields than could be attained otherwise if used in combination with other improved production practices.

By using such an analysis for his individual farm situation, the farm operator can determine whether it is feasible and profitable to invest in irrigation facilities for the various crop enterprises.

Numerous Tables.

S. C. Agr. Expt. Sta., Clemson, S. C.



Gerlow, A., and Mullins, T. RESERVOIRS FOR IRRIGATION IN THE GRAND PRAIRIE AREA: AN ECONOMIC APPRAISAL. Ark. Agr. Expt. Sta. B. 606, 24 pp. 1959.

Most of the reservoirs constructed in recent years in the area of study are located on cropland and are complete enclosures rather than impoundments with only one or two sides leveed. Cost of construction is directly related to the proportion of the reservoir that must be leveed. Cost of fill work for reservoirs with only one side leveed averaged \$37 per acre enclosed, whereas for complete enclosures the construction cost averaged \$106. The pumping plant for moving water into and out of the reservoir is a major item of cost. The smaller units, used mainly for discharging water, cost about \$1,900 each; the larger units, used mainly for filling the reservoir within short periods, cost about \$3,600.

The average investment for land, levee construction, and pumping plants for 20-, 40-, 80-, and 160-acre completely enclosed reservoirs averaged \$7,403, \$12,074, \$20,711, and \$38,249, respectively. The cost of land made up 41 percent of the total cost for 20-acre reservoirs and 63 percent of that for the 160-acre size. If wasteland were available, irrigation costs per acre could be reduced; with reductions of \$6.98 for 20-acre reservoirs and \$6.96 for 160-acre ones.

When completely enclosed reservoirs were used to irrigate an average of 1.7 acres of rice per surface acre within the reservoir, costs per acre irrigated were estimated to range from \$19.24 for a 20-acre reservoir to \$12.47 for a 160-acre one. Fixed costs would amount to 65 to 75 percent of the total for reservoirs of these sizes. Cost of irrigating from wells averaged \$14.42 per acre. Thus only the 80- and 160-acre reservoir would irrigate at a lower per acre cost than wells. Farmers with reservoirs used about 2.5 hours less labor per acre in irrigating rice.

Interviewed for the study were 66 farmers in Arkansas, Prairie, and Lonoke Counties.

Ark. Agr. Expt. Sta., Fayetteville, Ark.

Chase, D. WHEN THE WATER LEVEL DROPS . . . Farm Managt. 8 (2): 43-45. 1959.

Problems resulting from western agriculture's continuing water shortage are especially intense in areas where underground reserves are the primary source of irrigation water. While use of subsurface moisture is vitally important throughout western states, California, with 69% of its cropland under irrigation and one-quarter of all the irrigated land in the United States, leads in the amount of ground water pumped from subterranean sources.

Within California, ground water conditions vary widely but one of the most serious overdraft problems is in prolific Kern County. Difficulties have become industry-wide with farmers carrying on a 2-stage program to overcome the income eroding effects of dropping water tables. First, individual farming programs are being adjusted to meet changing water conditions and, second, farmers and those who work with them are united as an industry in efforts to obtain supplemental irrigation water.

Economic losses are only part of the picture. As the water table drops, profitable crops become marginal, then are outright income losers. More land lies idle and some permanent employees may have to be released. There is always the possibility that reduced acreage and income will reach the point where the operation will not maintain the families of the owner-operators.

Calif. State Polytechnic Col., San Luis Obispo, Calif.

Kottke, M. W. CAPITAL AND LABOR EFFICIENCY IN IRRIGATION. Conn. (Storrs) Agr. Expt. Sta. B. 345, 18 pp. 1959.

Installing an irrigation system on a farm requires a sizeable outlay of capital. Unlike most other new capital additions to a farm, irrigation uses more labor, not less. Because of these requirements certain conditions must exist on a farm before irrigation becomes economically feasible.

First, the crops irrigated should be sufficiently responsive to changes in the amount of water received so that the added value produced is greater than the added costs of irrigating. A 5 to 10 percent response is sufficient to produce a profitable return for potatoes, tobacco and lettuce whereas a 20 to 30 percent response is necessary for forage crops.

Second, the volume of irrigated production should be large in relation to the amount invested in an irrigation system. On high valued crops such as vegetables, potatoes and tobacco, an investment of about \$5,000 in a system is used on production worth about \$25,000. On forage crops a \$5,000 investment is used on production worth about \$5,000.

Connecticut irrigators use about 100 hours of labor irrigating on the 15 acre operations and about 500 hours irrigating on the 75 acre operations.

When volume is expressed in terms of the amount of water applied, forage irrigation on dairy farms had the least annual equipment cost per acre-inch of water applied. Their annual equipment costs per acre--inch range from \$4.40 to \$.90 as volume increased. Dairy farms also used the least fuel in relation to the amount of water applied (from 4.0 to 2.5 gallons of fuel per acre--inch as volume increased).

Third, the need for and use of irrigation should be rather continuous over a period of years. In 1958, which was a "wet year", very few dairy and tobacco farmers irrigated while 85 percent of the potato irrigators and 70 percent of the vegetable irrigators did irrigate. On a 40 acre forage operation the crop value saved by irrigation will have to be about \$1,000 or higher in half of the years in order for it to be profitable when irrigation is skipped about two years out of ten.

Fourth, the net returns to irrigation should be greater than the equivalent amount of capital and labor resources could earn in some alternative use. Dairy farms frequently have several alternative opportunities which are as profitable as irrigation. On the other hand, vegetable, potato and tobacco growers probably find that irrigation is one of their most profitable practices.

Conn. Agr. Expt. Sta., U. Conn., Storrs, Conn.

## Institutional and Educational

Christensen, R. P., Johnson, S. E., and Baumann, R. V. PRODUCTION PROSPECTS FOR WHEAT, FEED, AND LIVESTOCK, 1960-65. U.S.D.A., A.R.S. 43-115, 47 pp. 1959.

This report is intended to present an analysis of the production prospects for wheat, feed grains, and livestock for the 1960-65 period, and to relate prospective output to potential outlets. The projections of crop yields were made in cooperation with scientists in the Crops, Soil and Water Conservation, Entomology, and Agricultural Engineering Research Divisions of ARS.

The appraisal of wheat, feed, and livestock prospects for 1960-65 comes out above as follows:

1. With continuation of present prices, costs, and farm programs (including 28 million acres in the Conservation Reserve Program), we should expect excess production of wheat and feed grains unless serious drought intervenes.
2. Increased demand arising from population growth is likely to be more than offset by the expanded output resulting from continued increases in crop and livestock production.
3. If the projected output of wheat, feed grains, forage, and pasture materializes, increasingly large supplies of feed from each year's production will be available for substantial increases in output of livestock products.
4. If consumption of red meat increased by 7 pounds per person from the 1959 level, in accordance with projection of the 1940-59 trendline, the estimate of 15 to 18 million harvested acres of excess feed grains and wheat would be reduced by 5 to 6 million acres.
5. If annual wheat exports were reduced from 450 million projected in this report to 250 million bushels, the excess capacity would be increased by the equivalent of 10 million acres.

6. If the wheat and feed grains produced on the 15 to 18 million excess acres under average growing conditions were fed to additional meat animals, the number of pounds of red meat available for consumption per person would rise from 158 pounds in 1959 to about 173 pounds in 1960, and 181 pounds in 1965. An increase in red meat supplies of 10 to 15 percent per person would mean price trouble for livestock producers.

ARS, USDA, Inform. Div., Washington 25, D. C.

McArthur, W. C., and Saunders, F. B. RESOURCES AND INCOMES OF RURAL FAMILIES IN THE COASTAL PLAIN AREA OF GEORGIA. Ga. Agr. Expt. Sta. Mimeo. Ser. N.S. 79, 59 pp., illus. 1959.

A large segment of the rural population of this area is characterized by relatively low incomes. Analysis of the records of sample families in Economic Area 7 shows that about 63 percent of them received less than \$2,000 in net family earnings in 1957; approximately 28 percent received from \$2,000 to \$4,999, and about 9 percent received \$5,000 or more. Of the rural white families, 46 percent, and of the rural nonwhite families, 82 percent received less than \$2,000 in net family earnings in 1957. About 16 percent of the white families had net earnings of \$5,000 or more, while less than 1 percent of the nonwhite families had as much. The farm-operator families fared better than farm-wage and rural nonfarm families so far as percentages earning above \$2,000 were concerned, and families on commercial farms better than those of low-production farms.

The sample studied included 491 families, of which 301 were farm-operator, 91 farm-wage, 62 rural nonfarm, and 37 nonemployed rural, families.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Hendrix, W. E. APPROACHES TO INCOME IMPROVEMENT IN AGRICULTURE. EXPERIENCES OF FAMILIES RECEIVING PRODUCTION LOANS UNDER THE FARMERS HOME ADMINISTRATION. U.S.D.A. Prod. Res. Rpt. 33, 44 pp., illus. 1959.

In State economic areas in which the median income of all farm families in 1949, as reported by the census, was less than \$1,000, sample FHA families increased their incomes while under the program by an average of \$448 in the North, \$828 in the West, and \$397 in the South. In areas with median incomes of \$2,000 or more, the FHA families increased their incomes by about \$1,300 in the North, \$1,750 in the West, and \$1,431 in the South. Given similar median income areas, northern farm families made no greater progress than did southern families. The differences among areas make it appear that the low-income farm problem is likely to be solved only partly through adjustments by individual farmers, although individual plans, attributes and resources, as well as the general economic environment, underlie the income and progress differentials observed.

The resources commanded while the farmers were still under the FHA program, not those owned or used formerly, were the crucial factor in both incomes and progress. Differences in acreage per farm counted very little. The younger farm operators made the greater progress in both incomes and net worth while under the program. Value of working capital affected the incomes earned, and amount of FHA credit funds advanced affected the amount of working capital, incomes, and rates of progress. For each \$1,000 increase in credit funds advanced, over a range from \$500 to \$7,500, income was increased by an average of about \$320 in the South, \$260 in the North, and \$500 in the West. Neither incomes nor rates of progress differed greatly by tenure of farmers but differed less in the South than in the North and West. Incomes and rates of progress between white and nonwhite families in the South differed substantially, but in a comparison of operators between the ages of 30 and 49, having the same tenure status and the same amounts of farm resources and off-farm income, the differences disappeared. Because of the larger resource requirements for operator earnings of \$2,500 in the North and West, farmers in these regions probably need a higher equity in their agricultural resources than do those in the South.



These findings are based on a sample of 5,555 formerly low-income farmers drawn from the first 5 borrowers in each local county or area office in the United States who entered the program from 1947 to 1953 inclusive, and who paid their loans in full after the 1953 harvest and were still farming in 1954. It is believed that the relationships found would be equally applicable to the period since 1953 had later data been available for analysis.

ARS, USDA, Inform. Div., Washington 25, D. C.

Farm Economics Research Division. FARM-MORTGAGE DEBT AT NEW HIGH LEVEL. U.S.D.A., A.R.S. 43-107, 7 pp. 1959.

The outstanding farm-mortgage debt on January 1, 1959, totaled \$11,254 million, up \$747 million from January 1, 1958. This total is the highest of record; it surpasses by \$469 million the previous high reached in 1923.

All of the principal lender groups shared in the 7-percent increase in mortgage debt holdings from year-earlier levels. Compared with the rate of increase in the previous year, all operating banks increased at a greater rate; life insurance companies, and others increased at about the same rate; and the rate of increase of the Federal land banks and Farmers Home Administration was lower.

The distribution of the outstanding debt among the principal lenders shows little change over the previous year. The share held by the Federal land banks, which has been on the increase since 1954, continued upward through 1958. The share held by others increased for the first time since 1956. The proportion held by life insurance companies and banks, which started declining during 1956, continued downward.

The farm-mortgage debt outstanding increased during 1958 in all except three of the States - New Hampshire, Rhode Island, and Oklahoma.

Preliminary estimates of the amount of mortgage debt outstanding for July 1 indicate that farm-mortgage debt is continuing upward at a higher rate than during the comparable period in 1958. Loan activity by the principal lenders continued above year-earlier levels in number and value of loans during the first quarter of the year, except for Farmers Home Administration farm-housing loans, which were off sharply in both number and value. Interest rates have been higher this year than they were at the same time last year.

Charts and Graphs.

ARS, USDA, Inform. Div., Washington 25, D. C.

Farm Economics Research Division. FARM ECONOMICS PUBLICATIONS CURRENTLY AVAILABLE. U.S.D.A., A.R.S. 43-108, 16 pp. 1959.

This is a list of publications currently available from the Farm Economics Research Division. It is not a complete catalog of the Division's research publications. Much of the research of the Division is done in cooperation with State experiment stations, and research reports published by the cooperators are not included in this list.

ARS, USDA, Inform. Div., Washington 25, D. C.

Agriculture Research Service. CURRENT DEVELOPMENTS IN THE FARM REAL ESTATE MARKET. NOVEMBER 1957 - MARCH 1958. U.S.D.A., A.R.S. 43-74 (CD-49), 39 pp. 1958.

Farm real estate values advanced 2 percent or more in 25 States during the 4 months ended March 1, 1958. In the rest of the States, values were essentially unchanged. Sharpest increases during the winter, occurred in Florida, Louisiana, and several Northern Plains States, where the increase was 4 percent or more. The national index advanced 1 percent to a record high level of 156. This was 6 percent above the March 1, 1957 level.

During the year, values increased by 5 percent or more in 41 States. Two groups of States stand out with gains of 8 percent or more. One group consists of the Atlantic Coast

States extending from Maryland to Massachusetts. The other includes 3 of the Northern Plains States - North Dakota, Nebraska, and Kansas.

ARS, USDA, Inform. Div., Washington 25, D. C.

Jones, L. A. WHAT YOUNG FARM FAMILIES SHOULD KNOW ABOUT CREDIT.  
U. S. D. A., Farm. B. 215, 20 pp. 1959.

Credit is a means of achieving an objective. Credit enables a person to buy or invest when he does not have enough cash for the purpose. Intelligent spending and investing is basic to intelligent use of credit.

Before using credit it is wise to understand your current situation. Appraise your resources--your property, money, energy, management ability, and so on. Consider your present wants and objectives. Develop your future plans and goals. Only then can credit play a useful part in helping to build a good farm business and in improving family living conditions.

ARS, USDA Inform. Div., Washington 25, D. C.

Metzler, W. H. SUGAR BEET LABOR IN NORTHERN COLORADO. Colo. Agri. Expt. Sta. Tech. B. 63, 102 pp. 1958.

Colorado is a labor deficit sugar beet producing area. Increased mechanization has decreased the demand for many seasonal workers employed in spring sugar beet operations. As a result of the shortness of the earning season, more attractive year round employment opportunities have drawn many domestic workers away from the sugar beet fields.

The supply of domestic sugar beet workers has declined and costs of hand thinning have increased. Also, sugar beet production is becoming more concentrated in the hands of fewer growers who are turning to mechanization as a labor substitute.

Further progress toward full spring mechanization of the sugar beet thinning operation now depends upon advancement of modern techniques such as the development of single germ varieties, uniform planting methods and selective weed control measures.

Colo. State U. Expt. Sta., Fort Collins, Colo.

Taylor, C. C., and Burch, T. A. PERSONAL AND ENVIRONMENTAL OBSTACLES TO PRODUCTION ADJUSTMENTS ON SOUTH CAROLINA PIEDMONT AREA FARMS.  
S. C. Agr. Expt. Sta. B. 466, 36 pp. 1958. (Pub. 33, Southeast Land Tenure Research Committee.)

A significantly large proportion of Piedmont area farmers were found to be of advanced age, with the accompanying physical and other handicaps. They do not have the capacity to keep up with the technological innovations that would permit them to compete as commercial producers. Because their education and training is inadequate, their managerial capacity is restricted, and they do not develop alternative uses for surplus agricultural resources. Apparently, many of the agricultural problems of these farmers have resulted from the rapid and extensive technological and sociological changes that have occurred and to which they have been unable to adjust. They find it difficult to acquire the increased capital, additional land, and better managerial skills needed in adjusting to the changing agricultural economy. Solutions to these problems include the finding of alternative uses of resources; broadened training programs and improved dissemination of information; better information as to the nature and extent of shifts in land use, both within agriculture and between agricultural and alternative uses; and research directed toward the problem of acquiring the resources necessary for an efficient farm unit and the development of economically feasible alternative enterprise combinations suitable for various part-time farming situations. These conclusions are based on interviews with 2,068 residents of the Piedmont area in the summer of 1955.

S. C. Agr. Expt. Sta., Clemson, S. C.

Franklin, E. R., Fuhrman, W. U., and Parrish, B. D. ECONOMIC PROGRESS AND PROBLEMS OF COLUMBIA BASIN PROJECT SETTLERS. Wash. Agr. Expt. Sta. B. 597, 46 pp. Illus. 1959.

The Columbia Basin Irrigation Project is planned to irrigate 600,000 acres, which will double Washington's irrigated farm acreage. This report discusses development of farms on the project, and appraises probable future returns from farming.

Initially, individual ownership of land was limited to a single farm unit as laid out by project planners. Now one may own as much as 160 acres of project land, 320 acres for husband and wife. Farm operators may rent additional units. Part-owners and tenants now operate the largest farms and generally have the best land.

Land prices have been going up, partly as a result of generally rising land values in the country. However, to be eligible for water service from the project works, an owner may not have paid more than the appraised price set by the Bureau of Reclamation.

Most project land has been developed since 1952. Investment per farm unit during the first 3 or 4 years averaged \$21,000. In 1956, total farm investment was \$75 million; settler debt for all purposes was about \$15,000 per operator. A third of the credit was from the Farmers Home Administration, a fourth from commercial banks. On units developed 4 or 5 years, annual net returns averaged \$3,300 to owner operators, \$7,000 to renters, and \$8,600 to owner-renters. Generally, operators of more than one unit borrow most and have the highest incomes.

Budgets of typical project farms illustrate earning capacity. They show net incomes ranging from \$2,900 to \$7,000 for single-unit farms, and \$5,100 to \$15,900 for two-unit operations.

Wash. Agr. Expt. Sta., Pullman, Wash.

Swanson, E. R., Tyner, E. H., and Peterson, G. A. ECONOMIC INTERPRETATION OF AGRONOMIC DATA BY THE LINEAR PROGRAMMING TECHNIQUE. Soil. Sci. Soc. Amer. Proc. 22: 132-136. 1958.

Linear programming is a mathematical method of planning an operation in an optimal fashion. Optimality is necessarily rigorously defined. Depending on the problematic situation, it may mean the minimization of the cost of producing a given product, or the maximization of the profits from a business firm such as a farm. Mathematically the technique may be defined as the maximization of a linear relation subject to a set of restrictions. Linear programming is well adapted to farm planning in the Corn Belt where complex interrelations among enterprises exist.

The application discussed in this paper deals with an economic interpretation of alternative cropping and fertilizer programs. In the example presented, the interrelationships among (a) rotations, (b) fertilizer programs, (c) livestock enterprises, and (d) labor, capital, and land requirements are considered simultaneously in arriving at high-profit solutions for a period of 5 years. Since alternatives with respect to fertilizer programs may vary with respect to the timing of the capital investments, the choice of the type of fertilizer program may be dependent upon, among other things, the amount of capital available.

The development and utilization of the technique of linear programming has implications with respect to agronomic research. Insofar as programming models approximate reality, a systematic method is provided for identifying areas of needed experimental research. Inclusion in the models of alternatives from experimental data permits estimation of the economic consequences prior to adoption by commercial producers. Further, alternative farm practices that hitherto may not have been thought practical may be suggested to agronomists by the study of a programming model.

U. Ill. Ill. Agr. Expt. Sta., Urbana, Ill.



## BIOLOGY

### Fish

Green, B. L., and Mullins, T. USE OF RESERVOIRS FOR PRODUCTION OF FISH IN THE RICE AREAS OF ARKANSAS. Ark. Agr. Expt. Sta. Spec. Rpt. 9, 13 pp. 1959.

In the Delta counties of eastern Arkansas, some 25,000 acres of water were utilized in 1959 for production of food fish in rotation with rice. An additional 50,000 acres of reservoirs probably will have been installed for this purpose by 1960.

In the summer of 1958, a study of the production practices of 35 farmers in the growing of fish for food and the problems they encountered was initiated.

The principal problems encountered by the farmers are: control of wild fish; maintaining oxygen balance; parasite control; cranes; cotton insect poisons; poaching; levee deterioration; water lilies; harvesting; and marketing.

The principal benefits to the rice enterprise are: improved soil fertility; effective weed control; and, improved land surface. The minor benefits are: reduced cost of water for irrigating rice (where the reservoirs were also used as a source of water for rice); making use of nonproductive land; and supply of fish for home use and for recreational purposes; and prevention of erosion on fields with moderate slope during years when no crops would be grown.

The production of fish during the total period averaged about 200 pounds per acre for all reservoirs. On a 12 month basis, production averaged 141 pounds per acre when stocked with buffalo, bass and catfish, 121 pounds when stocked with buffalo only, and 88 pounds when stocked with buffalo and bass. The grass returns per acre averaged about \$22. per acre or \$16. per acre after the cost of stocking is deducted.

U. Ark., Fayetteville, Ark.

### Upland Wildlife

Stuart, W. J. WILD TURKEYS IN NEBRASKA. Soil Conserv. 25: 129. 1959.

In the fall of 1953, the Gordon Wildlife Club turned loose some wild turkeys on the Niobrara River, south of Gordon. These turkeys, imported from West Virginia, consisted of four hens and two gobblers. Today, about 100 turkeys are living near the river in a 20-square mile area.

Cooperators of the soil conservation district have encouraged the spread of the turkeys by applying such practices as stubble mulch tillage, improved range and pasture management, planting of field and farmstead windbreaks, and the growing of grasses and legumes for seed.

Work Unit Conservationist, SCS, Rushville, Nebr.

## SUPPLEMENT

### Problems Affecting Application

Benedict, W. V. EVERY FORESTER HAS A STAKE IN FOREST INSECT SPRAYING. J. Forestry 57: 245-249. 1959.

Insufficient attention has been given to the benefits that result from chemicals properly applied, and to the essential position chemicals must occupy in protecting and preserving forest values.

These enormous losses by insects are not going to be stopped by chemical sprays alone. Rather, a skillful blending of cultural, biological, and chemical measures, each coordinated with the other and with resource management is the only answer to a fully effective insect-control program. Better and more effective prevention, coupled with harvesting of overripe timber, can go a long way toward checking annual losses.

Chemicals come into play where other methods cannot do the job in time to avert serious damage to the forest. In combatting outbreaks of tree defoliators such as the

spruce budworm and pine butterfly, the forester has no other choice-- either he resorts to chemical spraying or he loses a forest.

There are two ways to combat forest insects with chemicals. One is from the ground by manual or mechanical application of a formulated insecticide to the individual tree, and the other is by releasing them from low-flying aircraft. Generally speaking, ground-applied chemicals are used on bark beetles and aerial applications are used against defoliators.

Results of extensive experience with chemical spraying of woodlands demonstrate that when insecticides are properly applied by trained people, with carefully prepared plans, damage to related values will be slight. We are continuing our search for safer chemicals and improved ways to apply them, and for other control methods.

Better detection and faster suppression, under a control objective of attacking insect outbreaks in their earliest stages, will result in a sharp decline in large control projects, but will result in a big increase in small ones.

We must not forget that the full impact of an unchecked forest insect epidemic is its overall effect on the community, timber, recreation, scenery, wildlife, and fish alike, plus the time required to heal the scars and restore all the forest benefits.

Keeping the public informed will go a long way toward keeping the forest manager's hands free to protect and manage his forest in accord with the best forest practices.

FS, USDA, Washington 25, D. C.

Furniss, R. L. ANSWERS TO SOME CRITICISMS OF AERIAL SPRAYING IN FOREST MANAGEMENT. J. Forestry 57: 260-262. 1959.

Aerial spraying is a comparatively new tool in forestry. For practical purposes, it came in with DDT during World War II. New chemicals are being applied aerially to forest lands to control insects, diseases, and unwanted plants, and to stimulate tree growth. These and other uses of chemicals are a promising means of increasing the nation's commercial wood supply.

We can say categorically that forest spraying, as currently practiced, presents little hazard that the insects will develop resistance.

We are learning that the effects of spraying upon fish are erratic, that under some conditions more fish are killed than at first thought. However, killing of game fish is seldom, if ever, complete in any one stream. In many streams no evident effects have shown up when it counts most--the catch of sportfish. In Oregon, many fine trout streams, among them such famous ones as the McKenzie and Metolius, have been sprayed without any indication from fishermen that the fish catch had been reduced.

Even when fish kill does occur, it is well to keep in mind that the sprayed area involves only a fraction of the fishing waters in a state. Further, fish populations build back much more rapidly than do trees. Finally, it should be recognized that uncontrolled insect epidemics often are followed by fire, which creates unfavorable fish habitats through siltation and loss of shade.

What must we do to meet the valid criticisms? First, we must continue to make sure that spraying is necessary in each case, and that it is the best method to use. Second, we must take all possible precautions to avoid damage, yet obtain maximum benefits from spraying. Third, we must continue to seek better methods and less harmful chemicals. Fourth, we must take positive action to retain aerial spraying as a forestry tool.

Pac. Northwestern Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

Rudinsky, J. A. SYSTEMICS IN THE CONTROL OF FOREST INSECTS. J. Forestry 57: 284-286. 1959.

The recent discovery that various organic phosphorous and flourine compounds with insecticidal properties are absorbed and translocated in a plant opened a very promising new field in plant protection.

It is evident that systemics will not entirely replace the conventional insecticides, but it is equally evident that they will be used against certain insect groups and in

situations where the latter are unsatisfactory or uneconomical. Certain important advantages in the use of systemics against forest insects are as follows:

1. The systemic insecticide absorbed by the plant may kill the injurious insects without affecting the beneficial ones.
2. Systemics give protection at surprisingly low rates of application and yet result in more equal distribution. Under forest conditions, it appears that foliage application, preferably by airplane, holds the greatest possibilities.
3. New shoots and branches growing after the treatment may still be protected from insect attack by the systemic within the plant, thus eliminating frequent application. Also, the insects feeding in concealed places protected from contact insecticides, such as aphids and mites, can be reached by systemics.
4. The long-lasting effect of some materials may protect trees or seedlings longer than conventional insecticides.
5. Seed treatment before planting may protect the seedling from insect enemies for a considerable time.

Many basic aspects, however, such as tree physiology, mode of absorption, translocation, and rate of concentration of systemics and their decomposition within the tree, as well as environmental and seasonal influence on these processes, must be better understood before practical methods of application under forest conditions can be developed.

Oreg. State Col., Corvallis, Oreg.

Yuill, J. S., and Isler, D. A. AIRPLANE SPRAYING IN FOREST INSECT CONTROL - EQUIPMENT AND TECHNIQUES. J. Forestry 57: 263-266. 1959.

Aerial application for forest insect control has come a long way since the first experimental dusting in Ohio almost 40 years ago - a long way even since the first trials with DDT in 1944. In this country over 10 million acres have been sprayed under the Forest Pest Act to control outbreaks of spruce budworm and other defoliators; an equal amount has been treated under the Gypsy Moth Control program; and even more extensive forest areas have been sprayed in Canada to combat spruce budworm. Only 15 years ago such outbreaks would have had to run their courses killing most of the infested trees.

The best time to spray is during the early morning, starting as soon as there is light enough to fly, but sometimes conditions also are satisfactory just before dark. Spraying should not be conducted when the wind velocity above the trees in the spray area exceeds 6 mph. It also is common practice to stop spraying when the temperature is greater than 68° F, because objectionable convection currents often occur at higher readings.

What about the future of aerial application? Eventually advances in silvicultural methods, tree breeding, parasites and other natural controls, we hope, will make our forest more resistant to insect damage. Even with the best natural control, however, it seems reasonably certain that there will be upswings in insect populations and aerial application will be needed to keep them in check, sometimes on widespread areas. Studies also are being made of the possibility of applying the insect disease viruses and other biological agents from aircraft.

Airplane spraying is not a panacea for all of our forest insect troubles. Many of our most important insect pests, such as the bark beetles, still must be controlled by other means. Nevertheless, the method has permitted, for the first time, a means for successfully controlling outbreaks of insect defoliators.

Forest Insect Lab., ARS, USDA, Beltsville, Md.

Dowden, P. B. WHAT ABOUT BIOLOGICAL CONTROL? J. Forestry. 57: 267-270. 1959.

The question whether biotic factors can be used to control forest insect pests comes up persistently whenever we are faced with economic losses, and properly so. Some spectacular successes have been achieved with the biological-control method.

Biological control has had its greatest use against introduced pests and its greatest success on island or ecologically isolated areas.



The European spruce sawfly and the European pine sawfly, are now controlled by biotic factors. Four pests--the gypsy moth, European pine shoot moth, larch case bearer, and larch sawfly--are partially controlled, and we are now importing the predators of the balsam woolly aphid.

The events in the Adirondacks and Maine seem to show, however, that biotic factors operate successfully from an economic standpoint as long as the outbreak remains localized, but are incapable of holding the insect in check when extensive areas become involved.

Entomologists have long sought practical methods for using insect diseases either for direct control, much as an insecticide is used, or for reducing insect populations permanently. Success has been achieved in a few cases, a notable one being the use of the milky disease of the Japanese beetle.

Great success has been achieved in the control of introduced scale insects infesting citrus trees in California through the mass rearing and liberation of parasites and predators.

One more possibility, control through the use of sexually sterile males, should be mentioned. This principle was used with spectacular success in eradicating the screw worm fly from the island of Curacao. Males were sterilized by irradiation in the pupal stage. When a female mates with a sterile male, she lays only infertile eggs and, since males mate repeatedly and females only once, the release of large numbers of sterile males gradually eliminated the natural population.

Northeastern Forest Expt. Sta., USDA, New Haven, Conn.

Warren, L. O. PINE SAWFLIES IN ARKANSAS. Ark. Farm Res. 7(1): 8. 1958.

The larvae of three species of sawflies (order Hymenoptera, family Diprionidae) are known to attack pine in Arkansas. They feed on the pine needles and, where numbers are sufficient, may completely strip a host tree of its foliage, thus reducing its growth.

The most spectacular damage has been caused by (Neodiprion taedae linearis Ross.), sometimes referred to as the "loblolly" sawfly or the "Arkansas" sawfly. It has appeared in at least 19 of the southern and central counties and in Washington County. Leconte's sawfly, (Neodiprion leconte) often called the red-headed sawfly, frequently appears as a pest in ornamental pines and pine plantings. Its distribution pattern covers the entire state. The third species, (Neodiprion sp.), known only to genus, appeared for the first time in the fall of 1957.

All three species are subject to parasitism by several species of parasites and disease organisms, and to predation by insects and rodents. Natural control usually is sufficient but occasionally locally severe infestations may occur which warrant chemical control.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Warren, L. O., and Coyne, J. F. THE PINE SAWFLY. Ark. Expt. Sta. B. 602, 23 pp. 1958.

The pine sawfly, (Neodiprion taedae linearis Ross,) has been a pest of loblolly and shortleaf pine in Arkansas for several years. In this state, loblolly is the preferred host. There is one generation a year, with winter passed as an egg in the needle of the host tree. Hatching occurs between the last of February and the first of April, with the larval feeding period lasting three to four weeks. Summer is passed in a cocoon in the soil. Pupation occurs about two weeks before emergence which takes place in late September, October, and early November. Adult activity is relatively short, ranging from 1 to 9 days under cage conditions, averaging 3.85. Mating may take place very soon after emergence. Oviposition occurs shortly after mating with females depositing an average of 71.4 eggs.

Above normal temperatures in December, January, and February shorten the length of the egg stage. In northern Arkansas this ranges from 154 to 175 days. Cool, wet, and cloudy weather may prolong the hatching period and result in a longer larval feeding period. Wet, cool, and cloudy weather also inhibits adult activity and reduces the number of eggs laid.

Although natural control factors such as weather, parasites, and diseases usually check infestations, this may not occur until spectacular damage has been done. Although attacked trees may suffer loss of growth, it usually is not sufficient to warrant the cost of chemical control measures unless defoliation continues extremely heavy year after year in the same stand of timber. When properly timed and applied, an aerial spray of one pound actual DDT to the acre in oil will give excellent control.

Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

Wylie, W. D. SINGLE APPLICATION TRUNK SPRAYS FOR CONTROL OF THE PEACH TREE BORER. Ark. Expt. Sta. B. 599, 24 pp. 1958.

Research studies conducted at several locations in Arkansas on the control of the peach tree borer have been discussed. The following conclusions are drawn from these studies.

A single application of dieldrin or BHC to the trunk prior to beginning of egg hatching is effective for the entire season in preventing newly hatched borers from entering peach trees.

A dosage of 6 pounds of 50% wettable dieldrin to 100 gallons is sufficient on trees with smooth bark in orchards where the borer population is not particularly high. A dosage of 12 pounds of 50% wettable dieldrin to 100 gallons should be used in orchards where the trees are rough and the borer population is high.

BHC is only slightly less effective than dieldrin for borer control. A dosage of 10 pounds of 12 gamma wettable powder to 100 gallons is almost as effective as higher dosages.

Thorough wetting of the trunk from the ground level up 8 to 12 inches is essential. One fourth pint of spray material should be sufficient for all except the very largest trees. Runoff of the spray material to wet the soil does not appear necessary.

Preliminary results indicate single applications of heavy dosages of DDT may not be as effective as dieldrin or BHC.

The use of a sticker appears to reduce the effectiveness of trunk sprays by decreasing the amount deposited and increasing the rate of loss of insecticide deposits from the trunks.

Trunk sprays should be applied by May 20 in southern Arkansas and by June 1 in northern Arkansas.

The manner in which the sprays are applied is optional so long as good coverage is obtained. A three-nozzle spray rod for rapid trunk spraying, which can be constructed simply and economically, is described.

Trunk sprays using relatively high concentrations of dieldrin or BHC have marked residual effectiveness against borers the year following application.

Paradichlorobenzene fumigation in the fall is effective in killing borers already established in the tree when used under favorable conditions. Ethylene dichloride and similar liquid fumigants have little advantage over PDB and the possibilities of injury to the tree may be greater.

Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

Gertler, S. I., and Butt, B. A. PRELIMINARY TESTS OF SOME CHLOROACETIC ACID ESTERS AS INSECTICIDES AND MITICIDES. U.S.D.A., A.R.S. -30-50, 10 pp. 1959.

In the course of screening a number of compounds as insecticides and miticides, several esters of chloroacetic acid showed some activity against selected species. In order to find more effective compounds and also determine any chemical structure relationships to toxicity, ninety-eight of these esters were prepared and tested against five species of arthropods (Boll weevil, Cotton aphid, Two-spotted spider mite, Salt-marsh caterpillar and Southern armyworm). The most toxic compound tested was (2 cyclohexyl-4, 6-dinitro) phenyl chloroacetate.

ARS, USDA, Inform. Div., Washington 25, D. C.

Field tests were conducted at four of the experiment stations in Georgia during 1957 to obtain further information on the effects of different rates of Thimet and Di-Syston applied as seed treatments and as granulated formulations in the furrow on plant emergence, insect populations, fruiting, and yield of cotton. At two of the stations, toxaphene spray was used as a comparison for control of early-season insects.

Results of stand counts showed no significant differences in the number of plants between treatments at any of the locations. Under the conditions of these tests, there was no adverse effect on germination due to any of the treatments.

At three of the locations, good control of thrips was obtained for a period of four weeks after planting with all of the insecticides. In the other tests, there were no significant differences between any of the treatments.

All of the systemic insecticide treatments gave highly significant reduction of aphids on seedling cotton for four weeks.

Results of square infestation counts showed that Thimet and Di-Syston were not effective in controlling boll weevil.

In two of the four tests, significant differences were obtained with several of the insecticide treatments in the number of blooms occurring during the first week. These results indicated a delay in fruiting. There were no significant differences between any of the treatments at the other two locations.

One interesting result that occurred in the test at Experiment was the systemic insecticides controlled spider mites throughout the season. All of the systemic insecticide treatments were equal in effectiveness in controlling or preventing the build up of this pest. The use of the systemic insecticides may therefore be of value in situations where mites are a serious problem in the same field each year.

A number of the systemic insecticide treatments also gave highly significant control or prevented the build-up of a heavy aphid infestation late in the season. Little reduction of aphid was obtained with the low rate of Thimet and the toxaphene spray treatments.

Data obtained on the percentage of cotton harvested at the first picking showed no significant differences between any of the treatments at two locations. Consequently, there was no indication of delay in maturity at these locations. Results were variable in the other test where records were taken and there was an indication of delay in maturity.

Yield records in the tests were inconsistent. In two of the tests, there were no significant differences between treatments in yields of seed cotton. The high rate of Thimet on seed was significantly different from the Di-Syston treatments but not the lower rate of Thimet and the lowest yield was obtained from this treatment in one test. However, in the other test, several treatments gave significant increases in yields of cotton.

Ga. Agr. Expt. Sta., U. Ga. Col. Agr., Athens, Ga.

Rouse, P., Rolston, L. H., and Lincoln, C. INSECTS IN FARM-STORED RICE. Ark. Agr. Expt. Sta. B. 600, 25 pp. 1958.

A survey of farm-stored rice in Arkansas County was conducted over two storage seasons. Data were taken on the incidence and severity of stored grain insect infestations, the sources of infestations, and the factors influencing infestations.

The prevalent species of stored grain insects in rice were the "bran bugs" that feed primarily on dockage. The Angoumois grain moth and lesser grain borer were the most frequently encountered species of primary stored grain insects. The rice weevil was relatively uncommon, and the cadelle was a rarity in farm-stored rice.

Infestations in ripe rice standing in the field are apparently unimportant. However, hairy fungus beetles were numerous in down rice. Trucks and harvesting machinery were frequently infested and stored grain insects, apparently from this source, were found in green rice being moved from the field into commercial driers. Rice leaving the driers was similarly infested.



Stored grain insects were commonly found in and around farm granaries before rice storage. Roughly two-thirds of other farm buildings from which stored grain insects may migrate into stored rice were found infested.

Several factors were found to influence stored grain insect infestations in farm-stored rice, especially the type of granary, aeration, and whether storage was with oats. When aeration was not employed, single-walled bins were much more frequently infested than double-walled bins. There was little difference between the two types of bins when aeration was used. Rice stored in the same granary with oats was more frequently infested than rice stored separately from oats. There was no consistent evidence that rice stored in bins used for oat storage during summer is more likely to be infested than rice stored in bins used solely for rice storage.

Grain protectants were not entirely successful in protecting rice. Fumigation of rice and oats, as practiced on the farm, was successful in about half the attempts observed. Low temperature of the grain is probably a contributing cause to failures in rice fumigation. Residual action following fumigation of rice was observed for approximately ten days.

Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

McLeod, A. G., and Thomson, R. THE EFFECT OF SEVERAL FUNGICIDES ON STEM ROT OF TOBACCO. New Zealand J. Agr. Res. 1: 866-873. 1958.

The importance of stem rot to the tobacco grower is discussed.

Two fungi, (Sclerotinia sclerotiorum) and (Botrytis cinerea) are the chief causes of the disorder.

Trials with fungicides in the seedling bed and in the field are described.

A good measure of control was obtained with ferbam, thiram, and dichlone.

Tobacco Res. Sta., Dept. Sci. and Indus. Res., Motueka, New Zealand

Lancaster, J. L., Jr. EFFECT OF TREATMENTS MADE FOR CONTROL OF FIRE ANTS. Ark. Farm Res. 8(3): 11. 1959.

In 1957, 11,000 acres were treated with granular heplachlor at a dosage rate of 2 pounds of actual material per acre. The first application, made sometime in May, 1957, was highly successful in killing out the fire ants.

Surveying for fire ant infestation continued. Fringe infestations were found, making it necessary to treat an additional 7,000 acres in 1958. Other points of new infestation, all small and apparently new colonies, have been found since and a new treatment is now underway. This follow-up is essential if the species is to be eradicated from Arkansas.

These treatments have provided opportunity to observe the effects of large-scale applications on insects and related forms of life. In February and April, 1958, trash samples were taken from 13 locations in the original treatment area and a comparable 13 samples from locations in an untreated area. A study of the samples indicated that there were fewer insects and related forms of life in the treated than in the untreated area. The figures were 159 and 205 respectively.

Prior work had indicated that such treatments would be effective against ticks. Counts made in 1958 and 1959 definitely brought this out. Mosquito control resulting from the treatment was reported for the entire season but no specific data were collected. Other pests, such as crawfish in lawns, were said to be controlled. Earthworms were killed in unprotected worm beds. Bee hives that were completely covered suffered very little damage. Hives only partially covered suffered loss of active bees from granules catching onto the drop board. Bees were also killed if they used water contaminated by the treatment. If fresh water was provided, this didn't happen.

It is evident that the economic benefits associated with treatment far outweigh any short-term detrimental effects that may have occurred.

U. Ark., Agr. Expt. Sta., Fayetteville, Ark.

Baines, R. C., Foote, F. J., Stolzy, L. H., Small, R. H., and Garber, M. J.  
FACTORS INFLUENCING CONTROL OF THE CITRUS NEMATODE IN THE FIELD  
WITH D-D. *Hilgardia* 29: 359-381. 1959.

When replanting citrus nematode-infested soil with susceptible crops, it usually is important to treat the soil with a 1,3-dichloropropene or other type of chemical for control of this nematode (*Tylenchulus semipenetrans* Cobb). Since the degree of control of the citrus nematode often is unsatisfactory, an effort was made to develop improved and highly effective methods for applying D-D type chemical in the field. The vertical diffusion pattern and efficacy of D-D for control of the citrus nematodes in a number of Yolo loam and silt loam soils were determined. When the D-D was applied at rates of 60, 90, 120, and 180 gallons per acre, 100 per cent of the citrus nematodes in the top 3 to 5 feet of soil frequently were killed. The amount of the chemical applied and the soil type treated affected greatly the degree of control. The effect of placement depth of the D-D in the soil, moisture content of the soil, time of year applied, and of some post-irrigation treatments on control were determined.

Calif. Agr. Expt. Sta., U. Calif., Berkeley, Calif.

Wakeland, C. THE HIGH PLAINS GRASSHOPPER A COMPILATION OF FACTS ABOUT ITS OCCURRENCE AND CONTROL. U.S.D.A., Tech. B. 1167, 168 pp., illus. 1958.

Assembled are some of the important facts about the High Plains grasshopper (*Disostertia longipennis* (Thomas)), records of its occurrence, and of Federal, State and farmer-rancher effects to control it. These facts are presented for the use of control and research workers.

ARS, USDA Inform. Div., Washington 25, D. C.

Animal Husbandry, Poultry, and Station Biochemistry Departments. SALINITY AND LIVESTOCK WATER QUALITY. S. Dak. Agr. Expt. Sta. B. 481, 12 pp. 1959.

This work describes the effects of saline waters on livestock and the level at which salinity makes a water unsuitable for livestock. Rats, cattle, swine, and poultry were used in the various studies.

In general, the results of these studies indicate that toxic effects can be expected from waters containing 10,000 p.p.m. of soluble salts, regardless of the type of salts. Waters with 7,000 p.p.m. of soluble salts apparently cause little, if any, real damage to livestock, but because of taste qualities and laxative effects from certain salts these waters cannot be considered as entirely satisfactory for livestock. Incorporating a reasonable margin of safety to provide for exceptional conditions, it appears that a water with over 7,000 p.p.m. of soluble salts should be classed as unsatisfactory for livestock.

Based on these studies and on observations made during the past several years, the following criteria are suggested for relating salinity to the quality of a livestock water:

Total Salts Content of Water* (p. p. m)	Quality
0-999.....	Excellent
1,000-3,999.....	Good
4,000-6,999.....	Satisfactory
7,000 and over .....	Unsatisfactory

\*Values for conductivity in micromhos per cm. at 25°  
C. may be used here if the total salts content is not know.

Other factors are, of course, important in determining the quality of livestock waters. These include such things as whether or not the water is excessively turbid, stagnant, or insanitary.

In addition, excessive nitrates, alkalinity (not to be confused with salinity), or unusual poisons make livestock waters unsatisfactory. Occasionally iron content is so high as to make a water objectionable because of its taste. Therefore, these factors must be considered in addition to salinity in evaluating a livestock water. Lack of experimental work prevents publication of standards relating to these factors at this time.

Agr. Expt. Sta., S. Dak. State Col., Brookings, S. Dak.

Peacock, F. M., and Kirk, W. G. COMPARATIVE FEEDING VALUE OF DRIED CITRUS PULP, CORN FEED MEAL AND GROUND SNAPPED CORN FOR FATTENING STEERS IN DRYLOT. Fla. Agr. Expt. Sta. B. 616, 12 pp. 1959.

Three drylot feeding trials, using grade Brahman shortyearling steers, comparing citrus pulp, corn feed meal and ground snapped corn for 140 days, have been completed. The data from these trials show that there were no significant differences in gain, TDN per 100 pounds gain, improvement in grade or dressing percent between steers fed citrus pulp, corn feed meal and ground snapped corn when combined with adequate protein and other essential nutrients in a ration for young growing steers.

U. of Fla., Agr. Expt. Sta., Gainesville, Fla.

### Soil-Plant Relationships

Wiegand, C. L., and Lemon, E. R. A FIELD STUDY OF SOME PLANT-SOIL RELATIONS IN AERATION. Soil Sci. Soc. Amer. Proc. 22: 216-221. 1958.

A attempt has been made to bridge the gap between the knowledge of the oxygen requirements of roots which has been gained through laboratory studies and the empiricism which now exists in field studies of soil aeration. This objective has been sought through a theoretical approach which combines field measurements of the oxygen supply in the gaseous and liquid phases of the soil and known quantitative demands by plant roots for oxygen into a single expression derived from Fick's Law for radial diffusion. The concentration of oxygen at the root surface is the soil aeration parameter determined.

The application of the theory to the quantitative evaluation of soil aeration condition in two contrasting soil types, Amarillo fsl and Miller c, has led to the following conclusions:

1. At field capacity, the concentration of oxygen at certain root surfaces is suboptimal for normal root respiration in Miller c1, but optimum in Amarillo fsl.
2. The concentration of oxygen at the root surfaces increases linearly with the logarithm of soil moisture tension.
3. The apparent diffusion path length in the liquid phase about plant roots is more often a limiting factor in normal root respiration than the gaseous composition, per se, in the soil pores.

The above conclusions, based upon the application of the theory, were tested against plant response. The results obtained indicate that the method shows promise as a tool to estimate the supply of oxygen to roots under field conditions.

SWCRD, ARS, USDA and Dept. of Agron. Tex. Agr. Expt. Sta., College Station, Tex.

Cline, R. A., and Erickson, A. E. THE EFFECT OF OXYGEN DIFFUSION RATE AND APPLIED FERTILIZER ON THE GROWTH, YIELD, AND CHEMICAL COMPOSITION OF PEAS. Soil Sci. Soc. Amer. Proc. 23: 333-335. 1959.

The growth and nutrient uptake of pea plants were studied over a range of rates of oxygen supply and fertilizer levels. Oxygen diffusion rates, which varied from very low to those adequate for plant growth, as determined by platinum electrode techniques, were obtained by varying the depth of water table.

Three fertilizer rates were used to determine the extent to which fertilization might alleviate low oxygen supply. Nutrient uptake was measured by chemical analysis of roots and tops of the plants.



In young plants high fertility may alleviate oxygen deficiency. When both fertilizer and oxygen supply were low, increasing the rate of fertilizer was more effective in increasing growth of young plants than increasing the oxygen diffusion rate. However, total growth and yield were closely related to oxygen supply. The pea plant was much more sensitive to oxygen deficiency during the last 25 days of growth in this experiment than during the first 50 days of growth.

Increased fertilizer rate in part compensated for a low oxygen supply but did not completely overcome the ill effects of oxygen deficiency. Under almost completely anaerobic conditions, application of fertilizer did not significantly increase growth or yield.

Roots produced under low oxygen supply were much coarser with fewer lateral roots than with ample oxygen supply. The number of nodules was much less under low oxygen supply.

J. Article No. 2344, Mich. Agr. Expt. Sta., East Lansing, Mich.

Eno, C. F. and Everett, P. H. EFFECTS OF SOIL APPLICATIONS OF 10 CHLORINATED HYDROCARBON INSECTICIDES ON SOIL MICROORGANISMS AND THE GROWTH OF STRINGLESS BLACK VALENTINE BEANS. Soil Sci. Soc. Amer. Proc. 22: 235-238. 1958.

Heptachlor, chlordane, methoxychlor, lindane, aldrin, toxaphene, dieldrin, TDE, DDT, and BHC were applied to Arredondo fs at rates of 12.5, 50, and 100 ppm. of the active ingredient. The soil was placed in 2-gallon pots and maintained in a greenhouse throughout the study.

The first crop of Stringless Black Valentine beans, planted 2 weeks after treatment, showed that BHC decreased germination; all other insecticides increased germination or had no effect. Root and top weights were decreased by chlordane, lindane, aldrin, dieldrin, TDE, DDT and BHC. Only top weights were reduced by methoxychlor. Heptachlor and toxaphene had no effect on growth. Germination and root growth of a second crop of beans, seeded 11 months after application of the insecticides, were not affected; top growth was significantly reduced by lindane, aldrin, TDE, DDT, and BHC.

Microbial data, obtained 1 month after application of the insecticides, indicated that they had no effect on the numbers of bacteria in the soil. Dieldrin increased the number of fungi; all others had no effect. Carbon dioxide evolution was increased by toxaphene, dieldrin, TDE, DDT, and BHC; the others had no effect. Nitrate production was decreased by heptachlor, lindane, and BHC; increased by toxaphene, TDE, and DDT; and unchanged by the others. Sixteen months after application of the insecticides no significant changes occurred in numbers of fungi and bacteria or carbon dioxide evolution. Nitrate production was reduced by DDT and BHC. Based upon the measurements made in this study, the growth of Stringless Black Valentine beans was influenced more than the microorganisms by the presence of insecticides in the soil. Until more specific information on microbial responses to these materials has been obtained, it appears that toxicity of higher plants will be the earliest warning of phytotoxic amounts of chlorinated hydrocarbon insecticides in the soil.

Agr. Exp. Sta., U. Fla., Gainesville, Fla.

Askew, H. O. MOLYBDENUM IN RELATION TO THE OCCURRENCE OF XANTHIN CALCULI IN SHEEP. New Zealand J. Agr. Res. 1: 447-454. 1958.

Samples of untreated Moutere Hills pastures contained from 0.03 p.p.m. down to unmeasurably small amounts of molybdenum in the dry matter, whereas pastures from other formations gave figures ranging from undeterminable amounts up to 0.4 p.p.m. Xanthin calculi have been found in Nelson only on the Moutere Hills formation.

Gorse tips eaten by sheep may contain more or no more molybdenum than pastures on the same area, according to location.

Copper contents of pastures and gorse tips were normal to high.

Sheep livers from healthy Nelson pastures were normal in molybdenum content. Livers from a field trial on an affected farm contained from 0.7 to 2.6 p.p.m. Mo; high molybdenum content was correlated with lessened incidence of calculus trouble. Down to 0.8 p.p.m. Mo has been found in other Nelson areas without occurrence of calculi.

Protein intake may be an important factor governing incidence of calculi.

Circumstantial evidence points to low molybdenum intake as a predisposing cause of calculus formation in sheep.

Cawthron Inst., Nelson, New Zealand.

Brown, J. C., Tiffin, L. O., Holmes, R. S., Specht, A. W. and Resnick, J. W.  
INTERNAL INACTIVATION OF IRON IN SOYBEANS AS AFFECTED BY ROOT  
GROWTH MEDIUM. Soil Sci. 87: 89-94, 1959.

Using a split-root technique, it was possible to demonstrate an internal inactivation of Fe in PI-54619-5-1 soybeans (PI), principally from the combined effects of P and Ca. Ca stimulated root growth, increased the absorption and translocation of P and Ca to the above-ground parts, but decreased the absorption and translocation of Fe in the presence of P.

A varietal difference in susceptibility to induced Fe deficiency was again observed. Hawkeye soybean remained green under conditions which induced Fe chlorosis in PI. This indicates a difference in the capacity of these two soybean varieties to absorb and hold Fe mobile in an environment which appears conducive to inactivation. Both foliar applied and soil Fe were affected. Quantity or quality of natural iron chelators in the plant is postulated as the factor responsible for this difference.

SWCRD, ARS, Beltsville, Md.

## SOIL SURVEYS

### Genesis and Morphology

Harris, S. A. THE GILGAIED AND BAD-STRUCTURED SOILS OF CENTRAL IRAQ.  
J. Soil Sci. 9: 169-185. 1958.

The variable soils of the recent alluvium of parts of Iraq contain horizons falling into two groups, viz. bad-structured horizons which are hard and dense with marked vertical cracking, and well-structured horizons characterized by a friable consistency and higher porosity. Gilgai occurs as the extreme bad-structured phase. The only constant difference in laboratory data between these groups is the low laboratory permeability in the bad-structured horizons. These features cannot be explained using the causes so far put forward for gilgaied soils in Australia, but they suggest an explanation of the process of formation of bad structure (in the agricultural sense) in terms of compaction by weathering agents. It is suggested as being a process which is habitually taking part in the development of solonetz soils, since the latter always seem to be characterized by this bad structure.

Land Use Div., Hunting Technical Serv. Ltd., England.

Butler, B. E. PERIODIC PHENOMENA IN LANDSCAPES AS A BASIS FOR SOIL  
STUDIES. Soil P. N. 14. Commonwealth Scientific and Indus. Res. Organ., Melbourne, Australia, 1959.

The occurrence of buried soils proves that soil development and erosion have been periodic rather than continuous. Since buried soils are widespread throughout the world, there is a case for developing a framework for soil studies on the basis of this landscape periodicity. This publication attempts to do this.

The fundamental idea is the soil cycle, comprising the alternation of a phase of instability when older soil surfaces are destroyed or buried, and a phase of stability when soil development proceeds on the new surfaces. The soil cycle is proposed as a time unit--a K cycle--and by the serial identification of these a chronological system is created. The evidence of the K cycles is to be found in the soil layers or ground-surfaces of a countryside, and the study of these, in sedimentary and stratigraphical terms, is outlined.

This study leads to an identification of the parent material and the time factor of the soil and places it in the history of the locality.

Commonwealth Sci. and Indus. Res. Orgain., Melbourne, Austral.

Kreida, N. A. SOILS OF THE EASTERN EUROPEAN TUNDRAS. Soviet Soil Sci. 1: 51-56. Jan., 1958.

Three soils subzones in various natural conditions may be distinguished in the tundra of the far north of the European part of the USSR: arctic, northern, and southern. The boundaries of these subzones coincide generally with the boundaries of the botanical subzones.

The tundra soils were formed as a result of a unique tundra soil-forming process, as shown in the biochemical process of surface gleying and in the periodic displacement of the products of soil formation along the soil profile, owing to infiltration of water during the warm period of the year and freezing out in the fall and winter. The weak or hidden podzolization of the tundra soils noted by a number of authors is an extremely rare phenomenon; it is a relict of ancient soil-forming processes at the period of the climatic optimum.

In the tundra zone corresponding to the vegetational subzones (arctic, northern and southern), three subtypes of tundra soils are distinguished:

1. An arctic soil-forming process which is close to the initial stages of soil development. Types: (a) structural soils with concealed gleying (developed on unclassified parent material); (b) polygonal and spotty soils (developed on classified parent material); (c) solonchak soils with concealed gleying (developed on salinized parent material in seashore regions).
2. Typical tundra soils. Types: (a) complex surface-gleyed and residual-gleyed soils (on fine-textured material); (b) illuvial-humic soils (on coarse-textured material).
3. Southern tundra soils with traces of podzolization. Types: (a) surface-gleyed podzolized (on fine-textured parent material); (b) illuvial-humic podzolized soils and dwarf podzols (on coarse-textured material).

Soils may be distinguished by their degree of surface gleying, illuvialhumic processes, leaching, freezing out, and so forth.

Amer. Inst. of Biol. Sci., 2000 P St., N. W., Washington 6, D. C.

Sherman, G. D., and Alexander, L. T. CHARACTERISTICS AND GENESIS OF LOW HUMIC LATOSOLS. Soil Sci. Soc. Amer. Proc. 23: 168-170. 1959.

The soils belonging to the great soil group of Low Humic Latosols have developed on basic crystalline rock materials in a semiarid to subhumid climate of subtropical and tropical regions having a pronounced dry period. The soil profiles of this group are characterized by the development of a weak  $A_1$  horizon in a solum which is predominantly kaolin clay. The solum is uniform in its chemical and mineral composition. The kaolin group make up 50% of the clay fraction, together with iron oxides and with small amounts of gibbsite.

The silica/sesquioxide ratios of the clay fractions of the soils of the Low Humic Latosol group range from 1.1 to 1.7, with the majority of soils falling within the range of 1.30 to 1.55. The silica/alumina ratios range between 1.7 to 2.3, with an average of approximately 2.0.

The physical properties of the soils of the Low Humic Latosol group are clays which have the physical properties characteristic of silty clay loams due to their high content of kaolin and iron oxide.

Col. Agr., U. Hawaii, Honolulu, Hawaii.



Tedrow, J. C. F., Drew, J. V., Hill, D. E., and Douglas, L. A. MAJOR GENETIC SOILS OF THE ARCTIC SLOPE OF ALASKA. J. Soil Sci. 9: 33-45. 1958.

The genetic soils of Arctic Alaska can be arranged in a drainage catena. The mature soils on well-drained sites are Arctic Brown and related soils. The Tundra profile is an imperfectly-to poorly-drained catena member. The Bogs, with permafrost, occupy many of the broad, flat, very wet areas. No evidence of a qualitative soil-forming process unique to the Arctic areas is found. Instead, the Arctic Tundra is primarily a northern extension of the hydromorphic soils of the forested regions, whereas the Arctic Brown and related soils represent the northern extensions of the podzolic processes. The term Tundra, when used in connection with zonal great soil groups along with Podzols, Chernozems, Laterites and related soils, is an erroneous one and its use, except for a hydromorphic soil, should be discouraged. The podzolic process on the stable, well-drained sites weakens northward, resulting in the successive development of Podzols, Minimal Podzols, Arctic Browns, Arctic Browns shallow phase, and, finally, no soil formation.

Rutgers - The State U., New Brunswick, N. J.

Schuylenborgh, J. Von. ON THE GENESIS AND CLASSIFICATION OF SOILS DERIVED FROM ANDESTIC TUFFS UNDER HUMID TROPICAL CONDITIONS. Netherlands J. Agr. Sci. 6: 99-123. 1958.

Morphological and chemical descriptions were provided of soils, derived from Andestic tuffs under conditions of high rainfall and perfect drainage, but on various altitudes. The physical and chemical differences were discussed on the basis of the rate and mode of destruction of the organic matter, on the diffusion of the carbon dioxide developed and on the nature of the clay formed.

Gerasimov, I. P. THE PRINCIPAL GENETIC TYPES OF SOIL IN CHINA AND THEIR GEOGRAPHIC DISTRIBUTION. Soviet Soil Sci. 1: 3-12. Jan. 1958.

This article describes the principal genetic types of soil in China and presents a soil map of the Chinese Peoples Republic--scale 1: 20,000,000 showing a generalized map of the genetic types.

Amer. Inst. of Biol. Sci., 2000 P St., N. W., Washington 6, D. C.

Wilson, G. V. THE LEETONIA SERIES IN VIRGINIA. Soil Sci. Soc. Amer. Proc. 22: 565-570. 1958.

The Leetonia soils occur in small areas throughout the Appalachian region of Virginia. They are characteristic Podzols of the region and are developed in highly siliceous parent material having low base status. Detailed field and laboratory studies were made of 3 profiles of the Leetonia soils, and field studies were made of 2 associated soils. The interplay and effects of the various soil-forming factors are illustrated by this study. Although the Leetonia soils are of minor extent, their contrast with associated soils in the landscape gives them stature in the study of the effects of soil-forming processes.

Cartographic Unit, SCS, Spartanburg, S. C.

Redmond, C. E. and McClelland, J. E. THE OCCURRENCE AND DISTRIBUTION OF LIME IN CALCIUM CARBONATE SOLONCHAK AND ASSOCIATED SOILS OF EASTERN NORTH DAKOTA. Soil Sci. Soc. Amer. Proc. 23: 61-65, 1959.

Calcium Carbonate Solonchaks occur in close association with Chernozems and Humic-Gley soils. Profiles have A<sub>1</sub>-C<sub>ca</sub>-C horizon sequence and form in calcareous parent materials. Evidence is presented to show that the prominent C<sub>ca</sub> horizon results from the precipitation of lime out of capillary water rising or moving laterally from a zone of water saturation. Technical descriptions of Hamerly 1, Hamerly-Aastad 1, Ulen lfs, Tiffany lfs, Bearden sicl, and Colvin sicl are presented.

SCS, USDA, and N. Dak. Agr. Expt. Sta., Fargo, N. Dak.

McClelland, J. E., Mogen, C. A., Johnson, W. M., Schroer, F. W. and Allen, J. S. CHERNOZEMS AND ASSOCIATED SOILS OF EASTERN NORTH DAKOTA: SOME PROPERTIES AND TOPOGRAPHIC RELATIONSHIPS. Soil Sci. Soc. Amer. Proc. 23: 51-56, 1959.

A study of the soils in the Chernozem Soil Zone in Eastern North Dakota is presented. Analytical data of Barnes, Aastad and Hamerly soil are presented along with the topographic relationship and profile characteristics of Buse, Barnes, Aastad, Hamerly, Cavour and Parnell. Technical profiles of Barnes 1, Aastad 1 and Hamerly 1 are presented along with a description of Northern Chernozems, Calcium Carbonate Solonchaks, Humic-Gley soils, Chernozemic Regosols, and Solonetzic soils.

SCS, USDA, and N. Dak. Agr. Expt. Sta., Fargo, N. Dak.

Mogen, C. A., McClelland, J. E., Allen, J. S., and Schroer, F. W. CHESTNUT, CHERNOZEM AND ASSOCIATED SOILS OF WESTERN NORTH DAKOTA. Soil Sci. Soc. Amer. Proc. 23: 56-60, 1959.

A study was made of the Chestnut, Chernozem, and associated soils of Western North Dakota. A description of the area, climate and native vegetation is presented, along with some characteristics of the most extensive Great Soil Groups: (1) Northern Chestnut; (2) Regosols; (3) Chernozem soils; and (4) Solodized Solonetz soil.

Chemical data and mechanical analyses of Morton 1, Williams 1, Noonan 1, Renville 1, Hamlet 1 and Hamerly 1 are presented.

SCS, USDA, and N. Dak. Agr. Expt. Sta. Fargo, N. Dak.

Johnson, P. R., and Beavers, A. H. A MINERALOGICAL CHARACTERIZATION OF SOME LOESS-DERIVED SOILS IN ILLINOIS. Soil Sci. Soc. Amer. Proc. 23: 143-146, 1959.

Six soil profiles (Joy sil, Muscantine sil, Ipava sil, Herrick sil, Cowden sil, and Cisme sil) representing successive stages of development in Peorian loess were studied by X-ray diffraction to determine any changes in mineralogical composition of the silt fraction in relation to their maturity. The quartz, albite, and microcline contents were determined using NaF as an internal standard. The dolomite content was determined with the carbon-induction furnace. The quartz content of the fine silt fraction increased progressively in the A horizons, did not change significantly in the B horizons, and increased slightly in the C horizons with distance from the loess source or bluff. Concomitant with the increase in quartz in the A horizons the feldspar content decreased, indicating the greater susceptibility of the latter to weathering. The slight increase in quartz content in the C horizons was due to the presence of dolomite in the younger soils. Quartz/feldspar ratios, an index of the weathering of the minerals, increased significantly for the fine silt fraction with increasing distance from the loess source. Albite weathered at a faster rate than microcline in the fine silt fractions. No significant change in the quartz and feldspar content of the coarse silt fraction was observed.

Ill. Agr. Expt. Sta., Urbana, Ill.

Cain, C. C., and Riecken, F. F. SEQUENCE RELATIONSHIPS OF LOESS-DERIVED FORESTED PLANOSOLS IN SOUTHEASTERN IOWA. Soil Sci. Soc. Amer. Proc. 22: 445-449, 1958.

According to genetic theory, the loess-derived soil series of southeastern Iowa can be arranged in a number of sequences. These sequences are the result of variations in (a) loess thickness, (b) topography, and (c) vegetation as factors of soil formation. As for a number of other sequences studied previously, there is increasing clay in the B<sup>t</sup> layer with decreasing loess thickness. The forested Planosols have an A<sub>1</sub>(A<sub>p</sub>)A<sub>2</sub>B<sub>g</sub>C<sub>1</sub> genetic horizon sequence. They have greater textural differences and a more abrupt boundary between the A and B horizons than any other sequence. In the forested Planosols,

there is a secondary accumulation of N and organic P in the B horizon; the free Fe tends to accumulate in the A<sub>2</sub>B transition layer.

Southwestern La. Inst., Lafayette, La.

Wurman, E., Whiteside, E. P., and Mortland, M. M. PROPERTIES AND GENESIS OF FINER TEXTURED SUBSOIL BANDS IN SOME SANDY MICHIGAN SOILS. Soil Sci. Soc. Amer. Proc. 23: 135-143. 1959.

Field and laboratory studies show that the nonlimy, more reddish, finer textured layers (B<sub>t</sub>) found in the subsoils of three coarse-textured soil profiles (Montcalm ls and fs, Coloma fs and Wallace s) in Michigan contain a considerably higher concentration of silicate clay minerals and "free iron oxide" than the adjoining sandier layers. These layers also have slightly more organic matter than the adjoining sandier layers, and considerably less organic matter than the B<sub>h1r</sub> horizons in the same or associated profiles. These textural bands may or may not be from the same initial material as the horizons immediately above or below them. They are wholly or in part the result of pedogenetic processes.

Both physical and chemical mechanisms are probably involved in the textural band formation. The existence of complexes of "free iron oxide"-silicate clay-organic matter in the soil and their ability to move through artificial columns containing natural nonlimy soil material was demonstrated in the laboratory. In addition, the movement of silicate clay and iron-organic matter complexes simultaneously or at different times can be postulated. The deposition of the individual complexes or a combination of them may be caused by a chemical interaction between them, physical factors such as wetting and drying of the soil, or the activity of a third agency on one or both of the mobile constituents, e.g., free lime flocculating clay and/or organic-iron complexes. Results indicate that a combination of the above mentioned factors is needed to explain the physical, chemical, and micropedological observations.

Wis. State Col., River Falls, Wis.

Stobbe, P. C., and Wright, J. R. MODERN CONCEPTS OF THE GENESIS OF PODZOLS. Soil Sci. Soc. Amer. Proc. 23: 161-163. 1959.

The authors review the literature (33 articles) on the formation of Podzols and have come to the following conclusions: The prevailing concepts of the genesis of Podzols are that the percolating decomposition products of organic matter, particularly the organic acids and other complexing substances, bring about the solution of sesquioxides, the reduction of Fe and the formation of soluble metal-organic complexes, some of which may be chelates. The complexes move to the lower horizons and are precipitated under oxidizing conditions probably by the destruction of the ligands by microorganisms and/or by sorption. While the theories involving complex formation and possibly chelation appear to be reasonable, more factual information is required before it can be definitely concluded that these processes play a major role in Podzol formation. More information is needed on the constitution, particularly the number and kinds of periphery groups, of the organic material(s) moving through the A<sub>2</sub> and into the B horizons. Also, the mechanisms advanced for the precipitation of sesquioxides to form the B horizon are based on inconclusive evidence and require further research.

The discussed chain of reactions, generally referred to as the podzolization process, must be strongly influenced and determined by the relative supply and concentration of reacting organic materials and of sesquioxides, by differences in the moisture regime, in the oxidation-reduction conditions, and in the reaction of the different horizons of the profile. Periodic seasonal changes in these conditions, the longevity and intensity of these changes and the associated changes in the concentration of the metal-organic complexes in the soil solution must also have a controlling influence on the podzolization process. Factual data on these influencing conditions probably would greatly assist in interpreting the marked differences that occur in Podzols.

Expt. Farm Serv., Dept. Agr., Ottawa, Canada.



McCaleb, S. B. THE GENESIS OF THE RED-YELLOW PODZOLIC SOILS. Soil Sci. Soc. Amer. Proc. 23: 164-168. 1959.

Red-Yellow Podzolic soils have developed under intense weathering conditions in humid, warm temperate, and tropical climates. Initially easily weatherable minerals are altered to secondary clays, oxides, and ions. As the bases are lost, segregation of insoluble oxides as amorphous materials occurs. Clays are apparently concurrently formed in place, the kind depending upon the source minerals, differential rates of solubility or weathering, and the ionic environment prevailing at the time. With time and changing environment, alterations proceed step-wise to form kaolinite in the instance investigated. Other clay species are assumed to be remnants of incomplete reactions and inherited differences associated with differences in environment. Thus step-wise mineral suites are observed within soil series associated with their position in time. The closer the look the greater are the differences observed.

Morphological changes also occur step-wise in response to differences in physical, chemical, and biological environments in time. Matrix colors seem dependent upon kind of original minerals, distribution in the original rock, and the time and environment sequence in which formed. As large pores are filled and B<sub>2</sub> horizons are thickened, mechanical filling and orientation of clays occurs. In situ alteration produces the bulk of the clay minerals and oxides with a large percentage remaining in place in the B<sub>2</sub> horizon because of mechanical filling from earlier formed and transported A horizon alteration products. Fluctuating moisture contents seem to be responsible for both the transportation and oriented deposition. With time, the thickness and continuity of clay-skin development proceeds upward in the profile. As lower areas are sealed off from effective movement, local rearrangement occurs in the B<sub>2</sub> horizon between grains and in small pores. Thus, the upward boundary of the B horizon is limited by the potential source of weatherable material in the A horizon. Transitionally from the bottom of the B<sub>2</sub> horizon, the clay-skin occurrence and development reflects this premise.

The B<sub>2</sub> horizon has thick continuous skins which are largely on vertical ped walls and in large pores. Horizontal ped surfaces have thinner skins as a result of dependence on local production and movement of in situ formed end products. C horizons show little oriented clay because movement is confined to interstitial cavities and small pores. Old root channels have oriented clay skins formed from horizons above.

It is suggested that criteria for the separation of B horizons be modified to include the distribution and mode of occurrence in addition to the total amount of clay present. Reticulate mottling in itself should not be a criterion for horizon delineation. Laboratory data confirm the field separations made, based upon the suggested horizon nomenclature changes.

The genesis of Red-Yellow and Gray-Brown Podzolic soils seems to be alike in kind, but differs considerably in the degree and intensity of expression of similar horizon sequences formed under quite different environments. The Red-Yellow soils of the United States are older genetically than the Gray-Brown Podzolic soils. This maturity is expressed in terms of degree of primary mineral alteration, dominant clay minerals suites present, amount of clay and its distribution, profile development, and the extreme acid conditions resulting from base depletion.

Clay Mineralogist, Sun Oil Co., Richardson, Tex.

Thorp, J., Cady, J. G., and Gamble, E. E. GENESIS OF MIAMI SILT LOAM. Soil Sci. Soc. Proc. Amer. 23: 156-161. 1959.

Miami silt loam and other Gray-Brown Podzolic soils of the United States and Canada are developed from calcareous parent materials of glacial, glacialfluvial or loessial origin; a large proportion of these materials were deposited during the Wisconsin stage of glaciation. Study of thin sections with polarized light shows clearly that much of the clay of the B horizon has been carried in by water and deposited. Studies of the clay fraction of the soil and parent material indicate that much of the clay was either unaltered or has been transformed from clay originally present, but that some was formed by weathering of primary minerals. Characteristics of the A horizon may be ascribed to the joint effects of leaching, eluviation, and the influence of the broad-leaved

deciduous forest and the associated macro- and micro-fauna. Recent leaching experiments, using "undisturbed" soil columns of Miami silt loam, suggest that B horizons are developed primarily through translocation of suspended fine clay and some humus, especially after the periods of soil drying in late summer and early autumn.

Earlham Col., Richmond, Ind.

Zaboyeva, I. V. GLEY-PODZOLIC SOILS. Soviet Soil Sci. 3: 237-244. March 1958.

As a result of this research it has been established that gley-podzolic soils, known as the zonal soils of the forest tundra and northern taiga, develop under definite conditions in the northern half of the central taiga as well. They are formed on elevated portions of the relief (at altitudes above 200 m. above sea level) on fine clay loams. This represents a shift of the soil subzones toward the south, that is, the soil is becoming adapted to the north.

The most characteristic genetic peculiarity of gley-podzolic soils is the gleying of the upper part of the profile, chiefly of the podzolic horizon. In this connection the accumulation of mobile forms of iron compounds takes place against a background of its general eluviation.

In gley-podzolic soils as in typical podzolic soils, there is an absence of a humus-accumulative horizon A (the formation of podzol develops in the almost complete absence of a peat-forming process). The principal source of soil humus is the litter of mosses. Because of the low ash content of this litter, the exchange acidity of the upper horizons usually exceeds the total of exchangeable cations in the same horizons. In this the exchange acidity is caused in the mineral horizons almost exclusively by aluminum (or iron), which is one of the genetic peculiarities of these soils.

Under the litter, gley-podzolic soils sometimes have an indistinct prehumified layer of 1 to 2 cm. This is not accumulative, but rather an illuvial horizon formed by humus which has penetrated this far from the surface litter.

Amer. Inst. of Biol. Sci., 2000 P. St., N. W., Washington 6, D. C.

Krebs, R. D., and Tedrow, J. C. F. GENESIS OF RED-YELLOW PODZOLIC AND RELATED SOILS IN NEW JERSEY. Soil Sci. 85: 28-37. 1958.

Occurrence and mineralogy of some red-yellow podzolic and related soils in New Jersey indicate that they have undergone a type or degree of weathering substantially different from that of soils north of the Wisconsin terminal moraine but akin to that of the red-yellow podzolic soils in the southern Piedmont. Most of this weathering probably occurred during one or more interglacial intervals. The occurrence and distribution of large amounts of kaolinite and/or gibbsite in the soil clays indicate a rock decomposition and clay-mineral genesis similar to that associated with laterization.

Of the hypotheses advanced to explain the genesis of red-yellow podzolic soils, the most tenable is that podzolization and lateritic weathering are operating simultaneously throughout much of eastern United States, the former more particularly toward the north and the latter toward the south.

J. Ser. N. J. Agr. Expt. Sta., Rutgers.-The State U., New Brunswick, N. J.

Kubota, J., and Lazar, V. A. COBALT STATUS OF SOILS OF SOUTHEASTERN UNITED STATES: II. GROUND-WATER PODZOLS AND SIX GEOGRAPHICALLY ASSOCIATED SOIL GROUPS. Soil Sci. 86: 262-268. 1958.

The cobalt status of a wide range of coastal plain soils in southeastern United States was determined using leaves of the swamp black gum (*Nyssa sylvatica* Marsh. var. *biflora* (Walt) (Sarge)) as the indicator for soil cobalt. Fifty-three sampling sites were selected where two closely spaced black gum grew a few feet apart. The sites were located in five states from North Carolina to Texas. The cobalt values in black gum sampled from ground-water podsol sites in North and South Carolina were dominantly less than 5 ppm. The cobalt values ranged from 10 to 295 ppm. in black gum sampled from the other sites, located on regosols, red-yellow podzolics, low humic-gleys, humic-gleys, and reddish-brown lateritic soils. The cobalt values were consistently high

in samples from Texas and from Newton County, Mississippi, where these soils predominate. The cobalt values indicate that ground-water podsoils are related to reported incidences of cobalt deficiency in animals in parts of the lower coastal plain.

U. S. Plant, Soil and Nutrition Lab., ARS, USDA, Ithaca, N. Y.

Schafer, G. M., and Holowaychuk, N. CHARACTERISTICS OF MEDIUM- AND FINE-TEXTURED HUMIC-GLEY SOILS OF OHIO. Soil Sci. Soc. Amer. Proc. 22: 262-268, 1958.

Humic-Gley soils are an important soil group in Ohio. In some western Ohio counties they comprise 20 to 25% of the upland soils derived from calcareous till. In the lake plain area of northwestern Ohio they are the dominant soil group. These soils have developed under conditions of poor or very poor drainage.

Profile descriptions and data for a number of prominent series developed from medium- and fine-textured materials are used to characterize the Humic-Gley soils. Variations in texture profile and B horizon development are shown. The horizon of maximum clay content is relatively near the surface in many profiles, and shows maximum development of strong, fine or medium, angular blocky structure and noticeable clay coatings on ped surfaces. Such horizons are considered the B<sub>2</sub> subhorizon even though the dark surface color extends to this depth. Reaction ranges from medium acid to neutral or mildly alkaline and remains relatively uniform or increases with depth. Base saturation is high. For 9 profiles base saturation at the surface ranges between 49 and 83% (only one profile below 69%) and increases with depth, approaching or reaching 100% in the lower part of the solum. Calcium is the predominant cation. A high-calcium status of the parent material appears to be associated with the formation of Humic-Gley soils.

Organic matter content is high. For 53 cultivated profiles the organic matter content ranges between 9.0 and 3.2% with the medium value of 5.4%. The organic matter content of the surface layer of 5 forested profiles varies between 8.3 and 11.8%. The carbon-nitrogen ratios vary between 10.3 and 14.0 in surface layers. The carbon-nitrogen ratio decreases with depth. Both illite and montmorillonite appear to be the common clay minerals of Humic-Gley soils.

Ohio Agr. Expt. Sta., Columbus, Ohio.

Anderson, J. U., and White, J. L. A STUDY OF FRAGIPANS IN SOME SOUTHERN INDIANA SOILS. Soil Sci. Soc. Amer. Proc. 22: 450-454, 1958.

Fragipans or "X" horizons have been recognized in highly weathered soils of southern Indiana for more than 30 years. They occur at depths of 2 to 4 feet, and are most common in imperfectly and moderately well-drained soils.

Profiles of three highly weathered soils of the residual area of southern Indiana were selected for study. A fourth profile which did not have a fragipan, but was formed from similar parent material was sampled for comparison. Detailed chemical and mineralogical studies were made on the nonfragipan profile and one of the fragipan profiles.

Each of the soils with fragipans had a pH of 4.5 or less in the B horizon. The profile without a fragipan had a minimum pH of 5.6. Horizons of one fragipan profile were shown to contain iron oxide as a cementing agent. The clay of the fragipan was found to be lower in montmorillonite than the clay from comparable horizons of the profile without fragipan. Only a small portion of this montmorillonite from the fragipan was capable of expansion without sample pretreatment.

U. Paper No. 1182, Purdue U. Agr. Expt. Sta., Lafayette, Ind.

Grossman, R. B., Fehrenbacher, J. B., and Beavers, A. H. FRAGIPAN SOILS OF ILLINOIS: I. GENERAL CHARACTERIZATION AND FIELD RELATIONSHIPS OF HOSMER SILT LOAM. Soil Sci. Soc. Amer. Proc. 23: 65-70, 1959.

Bisequal soils with fragipans are common in southern Illinois. The purpose of this introductory paper is to set the general framework for understanding the nature and occurrence of these soils through the description of the morphology, chemical and physical properties, and field relationships of Hosmer silt loam, a soil with moderate fragipan expression.



The bisequal nature and expression of the fragipan increase with decreasing loess thickness and with latitude from north to south. Maximal expression is in the low, moderately well-drained, topographical positions. It is suggested that these soils in Illinois are part of an interstate sequence extending southward into Mississippi, within the loess-derived soils of the Mississippi River Valley. Technical soil description, and physical and chemical properties of Hosmer sil are presented.

#### 43 References

SCS, USDA, Beltsville, Md.

Grossman, R. B., Stephen, I., Fehrenbacher, J. B., Beavers, A. H., and Parker, J. M. FRAGIPAN SOILS OF ILLINOIS: II. MINERALOGY IN REFERENCE TO PARENT MATERIAL UNIFORMITY OF HOSMER SILT LOAM. Soil Sci. Soc. Amer. Proc. 23: 70-73, 1959.

The mineralogy of Hosmer sil, and bisequal soil with a fragipan, was investigated in order to determine whether there is a lithological discontinuity between the parent material of the upper and lower sequum.

Differences observed between the two sequa in respect to the mineralogy of the heavy and light, silt-size fractions may be accounted for by a progressive decrease in the weathering intensity with depth and are not suggestive of a lithological discontinuity in parent material. The clay mineralogy for the B horizons of the two sequa was similar for the  $<0.2\mu$  and the  $0.2\mu$  to  $2.0\mu$  fractions, taken individually. However, for the total clay fraction, a higher percent of montmorillonite was found in the  $B_2$  horizon of the lower sequum; this may be explained on the basis of illuviation.

SCS, USDA, Beltsville, Md.

Grossman, R. B., Stephen, I., Fehrenbacher, J. B., and Beavers, A. H. FRAGIPAN SOILS OF ILLINOIS: III. MICROMORPHOLOGICAL STUDIES OF HOSMER SILT LOAM. Soil Sci. Soc. Amer. Proc. 23: 73-75, 1959.

Micromorphological studies of Hosmer silt loam, a bisequal soil with a fragipan, indicate that the  $B_2$  horizon of the upper sequum is at present an apparently stable, non-illuvial horizon, whereas the B horizons of the lower sequum are apparently illuvial in character, and in the process of degradation to form the encroaching  $A_2$  horizon. An attempt is made to relate resistance to rupture of the major horizons to their micromorphology.

SCS, USDA, Beltsville, Md.

Gile, L. H., Jr. FRAGIPAN AND WATER-TABLE RELATIONSHIPS OF SOME BROWN PODZOLIC AND LOW HUMIC-GLEY SOILS. Soil Sci. Soc. Amer. Proc. 22: 560-565. 1958.

Ground-water levels in relation to the fragipan were studied in Paxton, Scituate, and Ridgebury soils at two field sites in southeastern New Hampshire in 1956 and 1957. The first two series are Brown Podzolic soils and the last a Low Humic-Gley soil. Horizons of Scituate and Ridgebury soils at one of the sites were sampled for laboratory determination of particle size distribution, cation-exchange data, free iron content, and organic matter. Bulk density measurements were made of selected horizons, and thin sections for microscopic studies were prepared for parts of the fragipans. All three soils have coarse textures, low cation-exchange capacity, and low base status. Free iron oxides in the upper solum are lower in the Ridgebury than in the Scituate but the former has an appreciable concentration in the upper part of the fragipan. A mechanism is proposed for this concentration of iron oxides.

Ground-water levels were measured in a number of access wells. These measurements indicate that the water table (1) remains in the upper solum of Ridgebury soils during the late fall, the winter, and most of the spring, (2) remains in the upper solum of the Scituate soils for short periods and in the lower solum for long periods, and (3)

seldom rises above the fragipan in Paxton soils. Some of the factors affecting observed water tables are discussed.

SCS, USDA, State Col., N. Mex.

Fridland, V. M. PODZOLIZATION AND ILLIMERIZATION (CLAY MIGRATION).  
Soviet Soil Sci. 1: 24-32. Jan. 1958.

This article reviews the literature (29 references) on the formation on podzolic soils and gives a complete chemical analysis of four different types of soils to show that it is possible to assume that the differentiation of particle size and total composition of the soils studied is connected with two different processes: (1) the actual podzolization, that is, destruction of the clay fraction and the differential removal of the products of this destruction; and (2) the transfer of the clay fraction without destruction of the clay minerals.

The removal from the upper part of the soil profile of the clay fraction and of the sesquioxides and the concentration of silicates in this part of the profile may be the result chiefly of two processes: the destruction of the clay with differential removal of the products of this destruction (podzolization); and the movement of undifferentiated clay without destruction of the clay minerals (illimerization or clay migration).

The most important indicators allowing us to distinguish between podzolization and illimerization (clay migration) are the data regarding the total composition of the clay fraction and the micromorphological examination of the soil. We do not yet have enough similar data at our disposal to speculate on the geography of these two processes. However, using our data (both that published in the present article and some which is unpublished) and sources in the literature, we put forward the following considerations:

1. Podzolization predominates in typical podzolic, gleyed-podzolic, humicalluvial podzolic and sod-podzolic soils.
2. Illimerization (clay migration) predominates in soils related usually to the light-brown forest podzolized, brown podzolized (including the reddish, light-brown podzolized soils of Rumanian authors), in Parabraunerde, in the grey wooded soils, and in the yellow podzolic soils (zheltozem).
3. The combination of podzolization and illimerization is possible in a number of soils. Such soils would probably be related to some extent to the sod-podzolic soils, to some of the soils related to the light-brown forest podzolized (more acid) soils, and to some of the gray wooded soils and others.

Amer. Inst. of Biol. Sci., 2000 P St., N. W. Washington 6, D. C.

Brewer, R., and Haldane, A. D. PRELIMINARY EXPERIMENTS IN THE DEVELOPMENT OF CLAY ORIENTATION IN SOILS. Soil Sci. 84: 301-308. 1957.

Eluviation and illuviation of the clay-size particles has long been considered to be one of the major processes in the development of textural differentiation in soil profiles. Dilute clay suspension saturated with Ca, Mg, K, Na, or H were poured onto pure quartz beach sand, or silt in one series of experiments. In a second series of experiments variously cation saturated clays were added in varying proportions to sand and sand and silt mixtures and dried. The results of these experiments indicate (a) the saturating cation on the clay-size material has no effect on the degree of orientation developed; (b) clay illuviation can be accomplished by the upward movement of particles in suspension; (c) if soluble salts are not excessive in a soil profile, clay illuviation will result in the development of strongly oriented clay bands and coatings in the illuviated horizon; (d) if eluviated clay is flocculated in large pore spaces in the illuvial horizon with little or no admixture of sand-size material then it will be only weakly oriented; and (e) the presence of silt-size material has a disrupting effect on the orientation of illuviated clay-size material. Evidence from natural soil profiles supports these conclusions drawn from the laboratory data.

Commonwealth Sci. and Indus. Res. Organ., Canberra, Australia.

## Classification

Harris, S. A. THE CLASSIFICATION OF GILGAIED SOILS: SOME EVIDENCE FROM NORTHERN IRAQ. J. Soil Sci. 10: 27-33. 1959.

The discrepancies between the classifications of McGarity and Hallsworth et al. are summarized and confirmed with later descriptions by other writers.

Further evidence from Northern Iraq shows that gilgai occurs which forms a transition from normal to "tank" form in several topographic types. A further form of depression gilgai is described completing the four possible combinations of the lattice-A, wavy, and normal gilgai of Hallsworth et al. Depression forms from the limit of the area in which gilgai occurs are described.

A new classification into gilgai types (based on topography and dominance of shelf and puff) and varieties (based on the nature of the puff and the size of puffs and channels) is suggested.

Land Use Div., Hunting Technical Services Ltd., England.

Whiteside, E. P. A PROPOSED SYSTEM OF GENETIC SOIL-HORIZON DESIGNATIONS. Soils and Fertilizers 22: 1-8. 1959.

The purpose of this paper is to summarize some recent exploratory considerations in developing a system of genetic soil-horizon designations. The ideas and concepts presented here are reflexions of earlier suggestions in the literature, the deliberations of the Soil Horizon Committees of the National Cooperative Soil Survey Work Planning Conferences in the United States, particularly during 1953, 1954 and 1955, and many helpful suggestions received from those who helped to evaluate the 1953 and 1956 mimeographed reports of those committees. In addition the stimulating "Proposal for a Unified Designation of Soil Horizons submitted to the Congress of the Association for Soil Classification and Soil Cartography from Sept. 23-27, 1957, in Bonn, Germany, circulated by E. Muckenhausen" has recently come to the author's attention. Additional help from individuals working with soils throughout the world are needed at this time.

Mich. Agr. Expt. Sta., East Lansing, Mich.

Pierre, W. H. RELATIONSHIP OF SOIL CLASSIFICATION TO OTHER BRANCHES OF SOIL SCIENCE. Soil Sci. Soc. Amer. Proc. 22: 167-170. 1958.

A schematic diagram is presented as a basis for considering the interrelationships among the three general areas of soil science and the direct and indirect contributions of each to interpretations of soil types with respect to yield estimates, productivity ratings, and soil groupings for specific purposes. It is emphasized that there is need for more interpretative data based on soil type, that such data must be more quantitative and that this will require the closer working relationship of specialists in different areas of soil science. Specialists in soil classification and those in soil fertility and management, in particular, need to collaborate more closely in developing interpretative information relating to productivity ratings, and alternative system of management for different soil types. This will require more "team research," but such team research cannot be at the expense of basic research in the individual areas. It is pointed out, for example, that just as basic research in soil chemistry and mineralogy is needed for the improvement of soil classification, so basic research in soil morphology, genesis and classification is essential to progress in soil chemistry, mineralogy and other areas of soil science.

Iowa State Col., Ames, Iowa

Basinski, J. J. THE RUSSIAN APPROACH TO SOIL CLASSIFICATION AND ITS RECENT DEVELOPMENT. J. Soil Sci. 10: 14-25. 1959.

Due largely to the conditions in which they were working, Russian pedologists were the first to establish pedology as an independent science. From the beginning they regarded soil as an independent body with a definite morphological organization, expressed



mainly in the structure of the profile, and resulting from pedogenetic processes determined and directed by environmental factors. This concept of soil led them to adopt a genetic approach to problems of soil classification. Russian soil classifications differed according to the basis accepted, whether bioclimatic, geographical conditions, factors of pedogenesis, pedogenetic processes, or soil evolutionary history. In recent years attempts have been made to construct classification systems based on all these aspects of pedogenesis. The current Soviet trends in soil taxonomy must be regarded mainly as a further development of the traditional approach. Measures are taken to standardize soil nomenclature and improve methods of recognizing (diagnosing) and describing soil types, which are regarded as basic taxonomic units. The evolutionary-genetic approach is considered the only proper approach to soil-classification problems. The importance of organic aspects of soil evolution and formation processes is emphasized. More attention is given to the genetic subdivision of soil types into smaller and better defined soil groups. Interest in the systematics of cultivated soils is also growing.

Commonwealth Sci. and Indus. Res. Organ., Canberra, Austral.

## Mapping and Interpretation

Krantz, B. A. SOIL SURVEY INTERPRETATION--INTERPRETATION OF SOIL CHARACTERISTICS IMPORTANT IN SOIL MANAGEMENT. Soil Sci. Soc. Amer. Proc. 22: 155-156. 1958.

With the development and application of soil management research, crop production potentials have increased tremendously as compared to crop yields characteristic of the soil in its natural or virgin state. Thus, in a given soil we have become more interested in its response to management than in its native or present productivity level. The Cecil soils of the Southeast and alluvial desert soils of the West are good examples of soils which are relatively unproductive in their virgin state, but produce high crop yields when properly managed.

It is the purpose of this paper to discuss basic information needed to predict how a soil will react or respond to the application of alternative soil and water management practices. The basic soils information which the soil survey provides must be properly interpreted by the farm planner or advisor if he is to develop a soil and water management system suited to any given farm.

SWCRD ARS, USDA, Billings, Montana

Aandahl, A. R. SOIL SURVEY INTERPRETATION--THEORY AND PURPOSE. Soil Sci. Soc. Amer. Proc. 22: 152-154. 1958.

Soil survey interpretation comprises the organization and presentation of knowledge about characteristics, qualities, and behavior of soils as they are classified and outlined on maps. This knowledge should be organized and presented in ways that will help people to make more intelligent decisions in their uses of soils. Agricultural users should be helped to make proper choices from available alternatives in use and management of soils for plant production. Engineering users should be helped to make choices among possible designs for subgrades, types of foundations, and the like. Hydrologists should be able to estimate runoff and water yields more accurately. Soil survey interpretations should help these and other users to make full and effective application of the knowledge available about soils. Soil survey interpretations must be dynamic. The state of the agriculture arts and the economic conditions both change and as they change revised interpretations become necessary.

SCS, USDA, Lincoln, Nebr.

Klingebiel, A. A. SOIL SURVEY INTERPRETATION--CAPABILITY GROUPINGS. Soil Sci. Soc. Amer. Proc. 22: 160-163. 1958.

The capability classification is one of several interpretive soil groupings made for agricultural purposes. The capability groupings provide information at three different levels of generalization; namely, class, subclass, and unit.

In the early stages of conservation planning it is important to know for each kind of soil its location, extent, and general suitability for various uses. Soil maps interpreted into the eight capability classes provide this general information. Capability classes are set up so the soils having the greatest alternative uses are in class I and the least in class VIII. When uses are considered collectively, the risks or limitations become progressively greater from class I to class VIII land.

Capability subclasses within each of the classes other than class I denote the major kind of conservation problems. Four kinds of problems are recognized in defining subclasses: (1) Runoff and erosion; (2) wetness and drainage; (3) root zone and tillage limitations, such as shallow soil, stones, low moisture capacity, and salinity; and (4) climatic limitations.

Within each capability class and subclass the capability units provide specific groupings of similar soils. A capability unit is a group of soils that are nearly alike in potentials for plant growth and responses to management. That is, a reasonably uniform set of alternatives can be presented for the soil, water, and plant management of the soils in a capability unit, assuming that effects of past management are properly considered.

Soil Survey Interpretation, SCS, USDA, Washington, D. C.

Bartelli, L. J., and Peters, D. B. INTEGRATING SOIL MOISTURE CHARACTERISTICS WITH CLASSIFICATION UNITS OF SOME ILLINOIS SOILS. Soil Sci. Soc. Amer. Proc. 23: 149-151. 1959.

Soil moisture characteristics (15 atm.,  $1/3$  atm., etc.) were determined for 31 soil types representing the major great soil groups recognized in Illinois. In addition such physical properties as bulk density and mechanical analysis were also determined for the principal soil horizons. Available soil moisture and field capacity was shown to vary by textural classes for each soil group studied. For example it was found that silt loam soils of the Gray-Brown Podzolic averaged more available moisture in the A horizon than the Brunizems and Planosols. It was found that the available soil moisture was highly correlated with the  $1/3$ -atm. percentage but not correlated with the 15-atm. percentage. The available moisture was controlled principally by the silt fraction.

Ill. Agr. Expt. Sta., Urbana, Ill.

Stokstad, O., SOIL SURVEY INTERPRETATIONS FOR ENGINEERING PURPOSES. Soil Sci. Soc. Amer. Proc. 22: 164-166. 1958.

This short paper attempts to provide the background for the common interests shared by pedologists and engineers. Some engineering attitudes toward soils are discussed and a soil scientist's approach to soil engineering problems is suggested. The paper further describes the nature of a productive cooperation between pedologist and engineer and discusses the obligations of each in order that their efforts may best serve engineering needs.

Mich. State Highway Dept., Lansing, Mich.

Jacobson, H. G. M., and Swanson, C. L. W. EFFECT OF SOIL TYPE ON DURATION OF RESPONSE TO CONDITIONER. Soil Sci. 86: 216-219. 1958.

Carver sl, Enfield sil and Buxton cl were taken from wooded sites and brought together under a single climate and management (intensive vegetable growing). A synthetic soil conditioner (vinyl acetate maleic acid) was applied and the effect of soil type on durability of benefits to soil and crop was noted. Initially the sandiest soil responded most, but response lasted longest--3 to 4 years--on the soils with higher silt and clay concentrations. Retreatment after four seasons and 8 crops produced largest benefits on the soils with finer texture. The behavior of the soil with over 50 percent silt was generally intermediate between the sandy and clay loams.

The relative advantages of an amendment of synthetic soil conditioner and annual manuring depends upon soil type as well as economics. The synthetic material appears to greatest advantage on clay and silt, the natural material upon sandy soils.

Conn. Agr. Expt. Sta., New Haven, Conn.

Bishop, W. D., and Barber, S. A. THE EFFECT OF SOIL PHOSPHORUS COMPOUNDS ON SOIL TEST CORRELATION. Soil Sci. Soc. Amer. Proc. 22: 435-439. 1958.

Twenty soils representing the level upland and the depressional soils in the hydro-morphic sequence of profiles of the upland and lake plain catenas were characterized by the determination of pH, organic matter, clay content, acid-soluble phosphorus, water-soluble phosphorus, alkali-soluble phosphorus, organic phosphorus, and iron content.

When the above variables were included in a multiple correlation analysis using yield of phosphorus as the dependent variable, a multiple correlation coefficient of 0.931 was obtained. The elimination of all variables except acid-soluble and alkali-soluble phosphorus gave a multiple correlation coefficient of 0.851. The simple correlation coefficient for acid-soluble phosphorus was 0.557 and for alkali-soluble phosphorus 0.675. The increase in correlation where both acid-soluble and alkali-soluble phosphorus were used over the correlation for either one alone was significant at the 1% level. Hence, the use of both acid-soluble and a alkali-soluble phosphorus were required to explain the contribution of the different soil phosphorus compounds to yield.

Solubility curves of the 20 soils indicated that the soils were heterogeneous with respect to soil phosphorus compounds. The depressional soils from the lake plain catena contained more calcium phosphate and less iron and aluminum phosphate compounds than their counterpart in the upland catena.

Solubility curves for calcium phytate and other organic phosphorus compounds indicate that they are partially acid-soluble, suggesting that an acid extraction contains phosphorus from both organic and inorganic sources. This was supported by the fact that a significant correlation was obtained between organic matter and acid-soluble phosphorus.

U. Tenn., Knoxville, Tenn.





